



# The American Journal of Surgery



PUBLISHED MONTHLY BY THE YORKE PUBLISHING COMPANY, INC.

49 WEST 45TH STREET, NEW YORK 19, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

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NEW SERIES, VOLUME LXX

OCTOBER TO DECEMBER

1945

THE YORKE PUBLISHING COMPANY, INC.

NEW YORK

MCMXLV

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# CONTENTS OF NEW SERIES, VOLUME LXX

## ORIGINAL ARTICLES

|  |   |     |
|--|---|-----|
| Established Surgical Infections. Treatment with Urea-Sulfanilamide Mixture . . . . .   | {<br><i>Chester W. Brown</i> . . . . .<br><i>Leslie A. McClintock</i> . . . . .<br><i>Edward R. Neary</i> . . . . . | 4   |
| Ligation of a Supernumerary Ureter. Clinical and Experimental Study . . . . .  | {<br><i>Albert E. Goldstein</i> . . . . .<br><i>Ben Klotz</i> . . . . .   | 13  |
| Intervertebral Spine Fusion with Removal of Herniated Intervertebral Disk . . . . .  | {<br><i>J. M. Owens</i> . . . . .<br><i>Lieut. Comdr. H. G. Williams</i> . . . . .                                  | 24  |
| Fracture of the Zygomatic Bone and Arch Postoperative Headgear . . . . .   | <i>Major Adolph A. Schimer</i> . . . . .  | 27  |
| Acute Suppurative and Gangrenous Cholecystitis . . . . .   | {<br><i>Nathan Blumberg</i> . . . . .<br><i>Louis Zisserman</i> . . . . .   | 38  |
| Metatarsal March (Fatigue) Fractures . . . . .   | <i>Albert L. Leveton</i> . . . . .  | 49  |
| Chlorophyll and Adrenal Cortical Extract in the Local Treatment of Burns . . . . .   | <i>G. H. Collings, Jr.</i> . . . . .  | 58  |
| Esophageal Diverticulum . . . . .  | <i>Frank Bortone</i> . . . . .  | 64  |
| Modifications of the Trocar Method with Positive Pressure for Instilling Amniotic Fluid Concentrate Intra-abdominally at the Close of Operations . . . . .                             | <i>H. J. Merkle</i> . . . . .   | 68  |
| Modification of Radical Operation for the Cure of Ingrown Toenails . . . . .   | <i>Lieut. Col. William L. Sibley</i> . . . . .  | 79  |
| What Was Wrong with Whitehead's Work? An Appraisal of His Rectal Operation . . . . .   | <i>Chelsea Eaton</i> . . . . .  | 83  |
| Brodie's Abscess. Two Case Reports . . . . .   | {<br><i>Lieut. James W. Downey</i> . . . . .<br><i>Major Harold E. Simon</i> . . . . .                              | 86  |
| Congenital Eventration of the Diaphragm. Surgical Management . . . . .   | {<br><i>J. Dewey Bisgard</i> . . . . .<br><i>George E. Robertson</i> . . . . .                                      | 95  |
| Criminal Abortion. Three Case Reports . . . . .  | <i>Theodore Cianfrani</i> . . . . .   | 100 |
| Torsion of the Testicle . . . . .  | <i>Captain William J. Foley</i> . . . . .   | 105 |
| Granulocytopenia Complicating Sulfadiazine Therapy in a Severe Intestinal Injury. Report of a Case in Which Penicillin Was Employed to Supplement Other Therapeutic Measures . . . . . | {<br><i>Colonel James E. Fish</i> . . . . .<br><i>Major Harold A. Conrad</i> . . . . .                              | 109 |



|  |   |     |
|--|---|-----|
| Submucous Lipomas of Colon with Special Reference to Acute and Chronic Intussusception . . . . .             | { <i>Joseph A. Lazarus</i> . . . . .<br><i>Morris S. Marks</i> . . . . .}   | 114 |
| Fistula of Submaxillary Gland Following Excision of Thyroglossal Cyst . . . . .                              | <i>Lieut. Col. H. B. Jenkins</i> . . . . .  | 118 |
| Lymphosarcoma of the Small Intestine . . . . .   | { <i>Harry Berman</i> . . . . .<br><i>Captain Frank Mainella</i> . . . . .}   | 121 |
| Fetal Bones Passed in the Feces . . . . .  | <i>Ben Frublinger</i> . . . . .   | 126 |
| Improved Needle Holder . . . . .   | <i>Levon A. Akopiantz</i> . . . . .   | 128 |
| Anal Retractor for Use in Anorectal Surgery . . . . .  | <i>J. Rembrandt Helfrick</i> . . . . .  | 131 |
| Device to Protect the Projecting End of Kirschner Wires, Steinmann's Pin or External Fixation Pins . . . . . | { <i>Harold D. Caylor</i> . . . . .<br><i>Lee Witwer</i> . . . . .}   | 133 |
| Stethoscope for Doctors with Hearing Defects . . . . .   | <i>Lieut. Col. Harry M. Kirschbaum</i> . . . . .  | 134 |
| Historical Aspects of Cardiac Resuscitation . . . . .  | { <i>Robert F. Barber</i> . . . . .<br><i>Capt. John L. Madden</i> . . . . .}   | 135 |
| Pilonidal Disease. Management of Cysts, Sinuses and Abscesses in Naval Personnel . . . . .                   | { <i>Comdr. Emil Granet</i> . . . . .<br><i>Captain L. Kraeer Ferguson</i> . . . . .}   | 139 |
| Stricture of the Male Urethra . . . . .  | { <i>Major Thomas W. Botsford</i> . . . . .<br><i>Lieut. Col. John H. Harrison</i> . . . . .<br><i>Capt. Burdette E. Trichel</i> . . . . .} | 153 |
| Intussusception. Diagnosis and Treatment . . . . .   | <i>Lieut. Comdr. Orland F. Smith</i> . . . . .  | 158 |
| Value of Salpingography in Surgical Diagnosis . . . . .  | <i>Commander Phineas Bernstein</i> . . . . .  | 164 |
| Intestinal Injury and Fecal Fistula in Gynecological Surgery . . . . .                                       | { <i>Henry C. Falk</i> . . . . .<br><i>Samuel Hochman</i> . . . . .}  | 176 |
| Primary Treatment of War Amputations . . . . .   | <i>Major Elden C. Weckesser</i> . . . . .   | 184 |
| Internal Derangements of the Knee. Diagnosis and Treatment. . . . .  | <i>Major Bernard J. Mintz</i> . . . . .   | 189 |
| Roentgenologic Exploration of Sinus and Fistulous Tracts . . . . .   | <i>Lieut. Col. Benjamin Copleman</i> . . . . .  | 197 |
| Refrigeration Anesthesia. . . . .  | <i>H. Ogle Horner</i> . . . . .   | 201 |
| Hypoproteinemia in Surgery of the Thorax . . . . .   | { <i>Martyn C. Ratzan</i> . . . . .<br><i>S. A. Thompson</i> . . . . .}   | 213 |
| Use of Free Omental Grafts in the Thorax. An Experimental Study . . . . .                                    | { <i>Samuel Alcott Thompson</i> . . . . .<br><i>Boris Pollock</i> . . . . .}  | 227 |
| Constant Traction Dressing. . . . .  | { <i>Lieut. Comdr. W. James Gardner</i> . . . . .<br><i>V. B. Seitz</i> . . . . .}  | 232 |

|  |  |     |
|--|--|-----|
| Benign Giant Cell Xanthoma of the Knee Joint. . . . .  | {Lieut. Comdr. Robert F. Foote . . . . .<br>Captain Herbert C. Fett . . . . .}             | 234 |
| Postoperative Thrombosis of the Iliac Vein . . . . .   | {C. C. McCorriston . . . . .<br>C. M. Burgess . . . . .}                                   | 237 |
| Excision of the Elbow for Multiple Compound<br>Comminuted Fractures . . . . .  | G. J. Curry . . . . .  | 243 |
| Traumatic Brain Abscess and Meningitis. Cure<br>Effected with Penicillin and Sulfadiazine . . . . .                                      | {Mark Albert Glaser . . . . .<br>Mar W. McGregor . . . . .}                                | 249 |
| Thrombosis of the Brachial Artery Treated<br>with Successive Cervical Sympathetic Blocks . . . . .                                       | Lieut. Col. Harwell Wilson . . . . .   | 255 |
| Diverticulitis of the Vermiform Appendix. . . . .  | W. A. Altemeier . . . . .  | 258 |
| Reconstruction of the Common Duct with<br>Vitallium Tubes . . . . .  | A. V. Migliaccio . . . . .   | 261 |
| Pre-Columbian Middle America Medicine. . . . .   | R. J. Behan . . . . .  | 268 |
| Hemorrhage as the Most Frequent Cause of<br>Maternal Death. An Analysis of the Puer-<br>peral Deaths in Brooklyn, 1944 . . . . .         | Charles A. Gordon . . . . .  | 277 |
| Intravenous Obstetrical Anesthesia. Prelimi-<br>nary Report . . . . .  | Frederick M. Allen. . . . .  | 283 |
| Surgical Management of Femoral Vein Throm-<br>bosis . . . . .  | Eugene L. Lowenberg . . . . .  | 291 |
| Simplification of Split Skin Grafting. Gum<br>Acacia Technic. . . . .  | Captain Leonard R. Rubin . . . . .   | 302 |
| Control of the Thyroid Storm . . . . .   | Captain Irwin Schimmel . . . . .   | 308 |
| Experimental Transmission of Lymphogranu-<br>loma Venereum Virus through the Placenta. . . . .   | Hugo Hellendall . . . . .  | 320 |
| Use of Thrombin (Topical) in Transurethral<br>Resection of the Prostate . . . . .  | {Clarence G. Bandler . . . . .<br>Philip R. Roen. . . . .<br>Raymond Stept. . . . .}       | 337 |
| Urinary Stress Incontinence in the Female. A<br>Combined Gyno-uological Approach to Its<br>Correction . . . . .                          | {Walter J. Reich . . . . .<br>J. Lester Wilkey . . . . .<br>Harold E. Silverman . . . . .} | 341 |
| Phthalylsulfathiazole-'Sulfathalidine.' A Clin-<br>ical Evaluation in 122 Patients with Procto-<br>logic and Related Conditions. . . . . | Gaspar Angelo . . . . .  | 354 |
| A Method of Treatment for Pilonidal Sinus . . . . .  | Jacob K. Berman . . . . .  | 360 |
| Refrigeration Anesthesia. . . . .  | Dermont W. Melick . . . . .  | 364 |

|  |  |     |
|--|--|-----|
| Treatment of Intertrochanteric Fractures of the Femur. The Use of the Hanging Cast . . . . .                             | { <i>Capt. Joseph L. Posch.</i> . . . . .<br><i>William E. Abbott.</i> . . . . .}          | 369 |
| Newer Postoperative Trends . . . . .   | <i>DeWitt C. Daughtry</i> . . . . .  | 374 |
| Bicipital Tendovaginitis . . . . .   | { <i>Major I. W. Kaplan</i> . . . . .<br><i>Major B. L. Hawkins.</i> . . . . .}            | 383 |
| Acute Suppurative Appendicitis with Abscess Formation and Subsequent Perforation of the Anterior Abdominal Wall. . . . . | { <i>Louis J. Gariepy</i> . . . . .<br><i>Paul G. Henley.</i> . . . . .}                   | 386 |
| Polyps of the Appendix . . . . .   | { <i>Lieut. Col. J. William White.</i> . . . . .<br><i>Major Ralph C. Ellis</i> . . . . .} | 389 |
| Benign Tumors of the Duodenum . . . . .  | { <i>Burton P. Hoffman</i> . . . . .<br><i>David M. Grayzel</i> . . . . .}                 | 394 |
| Mixed Bacterial Gangrene of an Extremity Treated with Penicillin and Sulfadiazine . . . . .                              | { <i>Bernard N. E. Cohn</i> . . . . .<br><i>Emanuel Friedman.</i> . . . . .}               | 401 |
| Surgical Aspects of Certain Blood Dyscrasias. . . . .  | { <i>Damon B. Pfeiffer.</i> . . . . .<br><i>F. M. Simmons Patterson.</i> . . . . .}        | 408 |
| Primary Repair of the Parotid Duct . . . . .   | <i>F. T. Wallace</i> . . . . .   | 412 |

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-fourth Year of Continuous Publication*

NEW SERIES VOL. LXX

OCTOBER, 1945

NUMBER ONE

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## Editorial

### EARLY AMBULATION AFTER OPERATION

WHEN James Hilton delivered the Hunterian lectures at the Royal College of Surgeons in 1861, his subject matter was a radical departure from the topics chosen by his illustrious predecessors. Heretofore, the lectures had been confined to some phase of the then basic subjects of anatomy, physiology and clinical surgery, but Hilton elected to limit his discussion to the influence of mechanical and physiological rest in the treatment of surgical disorders. These lectures were embodied in a monograph entitled "Rest and Pain," a volume that was destined to become a classic. Hilton's theme was that the guiding principle of the surgeon should be to assist nature. To quote "It would be well I think if the surgeon would fix upon his memory the first professional thought which should accompany him in the course of his daily occupation, the physiological truth that nature has a constant tendency to repair the injuries to which her structures may have been subjected."

Hilton's emphasis on rest as an adjunct to surgical intervention has had a profound influence on the after-care of surgical patients for over three-quarters of a century. Like the declamation of many famous observers, as for example Osler's "Euthanasia at 60," his ideas like the

declamation of many of the famous men have been largely misinterpreted because only few have taken the trouble to study his lectures and so many have contented themselves with accepting the title alone of his book "Rest and Pain" as representing the gist of his teaching; whereas Hilton's emphasis actually was placed on physiologic rest which does not necessarily mean bed rest. Similarly William Osler's alleged championship of "Euthanasia at 60" which received such widespread newspaper publicity was based on faulty reporting, for those of us who were fortunate enough to hear his lecture on February 22, 1905, placed no such interpretation on his remarks. John Hunter, too, has also been widely quoted as advising bed rest for all diseased conditions, but as Sir Arthur Keith points out in his "Menders of the Maimed," Hunter prescribed rest only in the treatment of disablements of the motor system. Furthermore, he himself suffered from anginal attacks during the last twenty years of his life, during which period he continued at active work and produced some of his greatest contributions.

The theory and practice of continuous and prolonged bed rest after operations has been frequently challenged. Since the turn of the century most of the con-

tributions to surgical literature have been of European origin, though Ries published an enthusiastic report of his experiences with early rising in the *Journal of the American Medical Association* as early as 1899. Eugene Pool, in 1913, published a paper entitled "Systematic Exercise in Postoperative Treatment" in which he elaborated a definite set of exercises to be performed by the patient while still in bed. Designed primarily to prevent stagnation of blood in the venous system, and so guard against thrombophlebitis. These exercises were productive of other beneficial effects such as, diminution of muscular weakness and atrophy and the promotion of a feeling of well being in the patient. The author has employed these exercises in his practice with happiest results, since his days as House Surgeon at the New York Hospital when he was for three years associated with the originator of the method. Exercise in bed was but the forerunner of the revolutionary idea of early ambulation.

The proponents of getting patients out of bed within twenty-four hours of operation cite the following advantages: (1) Lowering of the incidence of postoperative pulmonary complications by promoting the cough reflex; (2) early movement of the legs stimulates circulation and thus prevents thrombosis; (3) stimulates early return of function to the gastrointestinal tract, thereby diminishing nausea, vomiting and distention. (4) beneficial physiologic effect on patient's morale, and (5) acceleration of convalescence resulting in a decreased period of hospitalization and earlier return to normal activities.

The rationale of the practice of early ambulation following surgical intervention has a very practical foundation. It is based on the observation that the postoperative course of children who cannot be restrained, of elderly people who are gotten out of bed immediately after operation to prevent pulmonary complications, and of those rugged individuals who insist on immedi-

ate bathroom privileges, are not adversely affected by early motion. In fact, they usually get along extremely well, often providing "seven day wonders" for conventionally minded nurses and house staff. The absence of ill effects following early rising was brought to our attention thirteen years ago when a sixty-nine-year old male went to the bathroom the evening of operation for strangulated femoral hernia, and continued to do so throughout his ten-day stay in the hospital. His hernia has remained cured and the scar is scarcely visible.

Though the application to surgical practice of the principle of early ambulation as exemplified in the foregoing groups of patients seems like such a short step, actually it has been more of the nature of a long jump. It remained then for Daniel J. Leithauser to put into everyday practice this revolutionary method in postoperative care. He has reported a series of 1,300 patients subjected to over thirty different surgical procedures including splenectomies, gastrointestinal operations, etc., in which the patients were gotten out of bed on the day of operation, or the first postoperative day. His experiences with this type of treatment have been excellent. There were only three deaths in the series, no one of which could be attributed to early activities. Complications were few. There was only one case of wound dehiscence, and one of thrombophlebitis. There were no incisional hernias, but there were five recurrences in seventy assorted herniorrhaphies. The elimination of serious pulmonary complications is credited to the stimulation of the cough reflex which occurs when the patient assumes the erect position. One has only to view Dr. Leithauser's motion picture film to become convinced of the great value of this observation. In a series of views depicting early rising after operation an obese female is seen standing up beside the bed on the day of operation. Immediately on assuming the erect position she

begins to cough and expectorates several ounces of thick tenacious mucus. The dire effects of retaining the secretion and the difficulties of promoting its evacuation by other methods are so familiar to those responsible for postoperative care that further comment is not required. Dr. Leithauser's results based on extensive experience with early ambulatory activity

are impressive. If his plan is adopted, he counsels against long vertical incisions and dependence on non-absorbable sutures. He advises transverse or short vertical incisions and the use of non-absorbable sutures. His work is a distinct contribution to postoperative care which merits further consideration and trial.

ROY D. McCLURE, M.D.



PATIENTS with fractures of the lower limb never should be transported until after splinting has been applied. Hospitalization is necessary for the modern treatment of fractures of the leg. Order x-ray examination before deciding upon the method of further treatment.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

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# Original Articles

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## ESTABLISHED SURGICAL INFECTIONS

### TREATMENT WITH UREA-SULFANILAMIDE MIXTURE

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THE topical use of sulfonamides alone in necrotic or purulent wounds is known to be of little or no therapeutic value. On the other hand, reports of experimental and clinical studies indicate that, in the local treatment of grossly infected wounds, urea-sulfonamide mixtures possess valuable antibacterial and related therapeutic properties.

Holder and MacKay<sup>1</sup> have investigated mixtures of urea (carbamide) and sulfonamides in wound therapy and have pointed out that urea enhances the antibiotic activity of sulfonamides (1) through a process of chemical débridement that rids the wound of necrotic tissue and cellular débris which give rise to sulfonamide-antagonists; (2) by solubilizing the sulfonamides, thus producing higher local concentrations of these drugs; (3) through hypertonic action and consequent local diapedesis, thus increasing the active cellular defense reaction within the wound.

Experiments by a group at the University of Minnesota demonstrated *in vitro* that urea inhibits the antisulfonamide action of methionine and para-aminobenzoic acid,<sup>2</sup> that in the presence of para-aminobenzoic acid the combination of sulfanilamide and urea possesses bacteriostatic activity in concentrations in

which neither sulfanilamide nor urea alone shows antibacterial effect.<sup>3</sup>

One of us (L. A. Mc C.) has shown *in vitro* that the inactivation of sulfanilamide by concentrated solutions of protein and protein hydrolysate is prevented by urea, apparently through a deterrent effect of urea on the binding of sulfanilamide by protein or products of early protein hydrolysis.<sup>4</sup> Additional experimentation in the latter study also corroborated findings of other investigators, namely, that the antibacterial effect of sulfanilamide is potentiated and the antisulfonamide activity of para-aminobenzoic acid is inhibited by urea.

Although these and other published observations suggest the advantages of urea-sulfonamide mixture in local chemotherapy, the need for more careful clinical appraisal of combinations of urea and sulfonamide in topical treatment of accessible infections has not been adequately satisfied. Strakosch and Clark<sup>5</sup> have studied the comparative rate of healing in a small group of patients with bilaterally infected dermatoses, in which sulfathiazole was applied to one affected area and urea-sulfathiazole to the other in the same patient. These investigators observed a definitely shortened healing time in most of the urea-

sulfonamide treated lesions and also reported successful therapeutic results with urea-sulfathiazole in two cases of pyoderma caused by sulfonamide-fast *Staphylococcus aureus*. Ilfeld<sup>6</sup> has employed urea-sulfonamide mixtures in local chemotherapy of a small series of fresh contaminated wounds consisting of compound fractures and other severe trauma. He concluded that application of urea-sulfonamide mixture to fresh contaminated wounds, as a first aid measure, allows a long delay before definitive surgery and, as an adjuvant to formal surgery, permits primary closure and healing. Unfortunately, as indicated by the author, this investigation lacked a strictly comparable series of cases treated locally with sulfonamide alone and, consequently, any conclusions concerning the relative value of sulfonamide with and without urea are somewhat nullified.

#### PRESENT STUDY

*Urea-Sulfanilamide Mixture.* The purpose of the investigation to be described in this report was to evaluate urea-sulfanilamide mixture in the local treatment of established surgical infections, most of which were chronic in duration.

The urea-sulfanilamide, which was used for topical treatment of all cases, was a crystalline mixture consisting of three parts of urea and one part of sulfanilamide. This specific mixture was selected as most satisfactory on the basis of experimental and clinical observations indicating that the crystalline components in this ratio, when generously applied to a wound, supplied the maximal percentage of relatively insoluble sulfanilamide which would not give rise to foreign-body reaction, and an excess of freely soluble urea sufficient to assure its prolonged action *in situ*.

Our urea-sulfanilamide mixture was supplied in sealed, resilient, plastic tubes, within which the crystalline drugs had been sterilized by a non-toxic, chemical process that does not adversely affect

either urea or sulfonamide crystals. Effective heat-sterilization of the mixture is not practicable, as pointed out by McClintock and Goodale,<sup>7</sup> since melting of the urea and decomposition of the mixture occur at sterilizing temperatures.

Other investigators of urea-sulfonamide dusting powders in the treatment of wound infections have presumably used unsterilized combinations of these drugs. However, the importance of effective sterilization of urea-sulfonamide mixtures is apparent in the Food and Drug Administration's finding that viable spore-forming anaerobes frequently contaminate unsterilized sulfonamide powders.<sup>8</sup> As emphasized by the authors of the foregoing report, possible presence of pathogenic anaerobes in sulfonamide dusting powders to be used in deep wounds constitutes an unnecessary hazard that can be eliminated by proper sterilization. This potential hazard of unsterilized sulfonamide dusting powders is equally applicable to unsterilized crystalline mixtures of urea and sulfanilamide.

The plastic tubes,\* which served as containers for our urea-sulfonamide mixture, proved to be efficient insufflators for the crystalline mixture. They enabled the operator to make uniform applications of urea-sulfanilamide to the entire surface area of an infected wound. Moreover, because of their tubular shape and their size, the containers also were adapted to insertion into large sinus tracts and wound recesses and thus facilitated the insufflation of the chemotherapeutic mixture into infected sites that were otherwise inaccessible.

*Clinical Material.* Sixty hospitalized cases of serious—chiefly chronic—surgical infections have been studied. Representing most of the usual variety of such infections seen in general hospital practice, these consisted of hematogenous and post-traumatic osteomyelitis, purulent and necrotic

\* The insufflator tubes of sterile urea-sulfanilamide, used in this study, were supplied by White Laboratories, Inc., Newark, N. J.



skin defects that required grafting, pulmonary abscess and thoracic empyema with external sinus tracts, and miscellaneous cases including infected postoperative wounds, trophic ulcers, etc.

In addition, several cases of suppurative peritonitis have been studied, particularly to determine the rate of absorption of sulfonamide from an infected serosal surface following the topical application of urea-sulfanilamide. In all cases in which the infected wound was external, the lesion was dressed once daily and the entire surface area of the wound freely covered with insufflated urea-sulfanilamide. This required daily application of 3 to 20 Gm. of the mixture per patient. In cases of draining lung abscess and empyema, 10 to 30 Gm. of urea-sulfanilamide per day were applied locally after insertion of the insufflating container into the short sinus tract. The more devious fistulous tracts were filled daily with the mixture by means of a soft rubber catheter attached to the insufflating container. Intraperitoneally, a single dose of 10 to 20 Gm. of urea-sulfanilamide was implanted at the time of operation.

*Method of Study.* Careful appraisal of a chemotherapeutic agent in surgical infections requires a plan of investigation that considers the many variable factors which may influence results, including among other determining elements the duration, previous treatment, extent of tissue destruction and bacterial population of such infections.

Meleney<sup>9</sup> has recently emphasized that the evaluation of drug therapy in established surgical infections is much more difficult than the appraisal of drug prophylaxis in contaminated wounds. In determining the prophylactic value of a drug in potentially infected or contaminated surgical wounds, control cases that are rigidly comparable with those in which the drug is to be used are both practicable and necessary. However, in appraisal of a drug in the treatment of established surgical infections, particularly of the

chronic type in which markedly variable factors have been or are operative, strictly parallel controls are not available for comparison with drug-treated patients.

In the series of surgical infections which represent the clinical material of the study described in this report, the cases have been largely chronic. Comparable control cases could not be studied. Therefore, in attempting to evaluate local chemotherapy of such infections with urea-sulfanilamide, it has been necessary (1) to consider these infections, in their previous treatment, as their own controls and (2) to compare results of treatment by urea-sulfanilamide with those which we would expect on the basis of past surgical experience.

*Bacteriologic Studies.* Frequent studies of the qualitative and quantitative bacterial population of all wounds provided a means of confirming clinical response to treatment with urea-sulfanilamide. Wound cultures were made at the start of treatment and, insofar as possible, every three to five days during treatment with the mixture. Specially prepared swabs, which absorbed approximately 0.1 cc. of fluid, were used to obtain samples of wound exudates. From saline suspensions of these, aerobic and anaerobic cultures and colony counts were made on meat infusion agar with dextrose and on solid thioglycollate agar, respectively. Cultures on blood agar and in tryptose phosphate broth were also routine. In addition, estimation *in vitro* of the antibacterial threshold concentrations of sulfanilamide for organisms isolated from certain wounds at the start of treatment helped to establish the degree of sulfonamide-resistance that these bacterial invaders manifested in failing to respond to earlier treatment with sulfonamide alone.

Periodic hemopoietic, blood chemistry and other pertinent laboratory studies were made in all cases. Clinical progress was charted and recorded in the usual way.

Results of treatment with urea-sulfanilamide have been classified, following the

recommendation of Meleny,<sup>9</sup> from the standpoint of the effect of the drug mixture on the infectious process:

- "Excellent," when the result was promptly and surprisingly favorable
- "Good," when the beneficial result was definite but not particularly unusual
- "Questionable," when the beneficial result was probably brought about by factors other than the drug mixture, too delayed to be significant, or in general doubtful
- "No effect," when the result was definitely unfavorable and the progress of the infection remained unchanged in spite of treatment with the drug mixture

#### RESULTS

Case history data and results of treatment with urea-sulfanilamide are compiled in Table I. In this tabulation cases have been grouped, to facilitate general discussion, under the headings: "Osteomyelitis," "Infected Skin Grafting Sites," "Thoracic Surgical Infections" and "Miscellaneous Surgical Infections." A summary of results in each of these groups of cases is contained in Table II.

#### COMMENTS ON RESULTS

We hesitate to draw any conclusions from our observations concerning the value of urea-sulfanilamide mixture in chronic hematogenous osteomyelitis. Since this disease is characterized by spontaneous remissions of many years, a method of chemotherapy cannot be easily evaluated. Suffice it to say, therefore, that in our cases of hematogenous osteomyelitis the local slough was promptly disposed of by urea-sulfanilamide and subsequent healing was somewhat shortened. In our cases of traumatic osteomyelitis we usually observed a gratifyingly favorable response, that could more definitely be ascribed to local treatment with urea-sulfanilamide.

The group of cases in which, on the

whole, we noted most impressive results was that consisting of grossly infected skin defects that were being prepared for grafting. In such cases, it is frequently of the utmost importance to shorten the time of preparation. Third degree burns over flexor surfaces or in other areas where contractures would be disabling or disfiguring should be grafted as early as possible. It is well recognized, too, that for a thick graft the recipient site should be as sterile as practicable. We have used a graft of  $2\frac{2}{1000}$  inch (estimated  $\frac{2}{3}$  full thickness) on a deep facial burn prepared with urea-sulfanilamide (Case 8) with primary healing and a 100 per cent "take." It has been possible by treatment of severely infected skin defects with urea-sulfanilamide to cause the bacterial count of the wound culture to decrease from 100,000 and more per cc. to "no viable organisms," in some instances within eight to ten days. Such potential sterilization of the recipient site, together with the extremely vascular granulation observed to result from local treatment with urea-sulfanilamide, produces an ideal bed for a graft. (Figs. 1 and 2.)

In our series of ten patients with grossly infected skin defects that were prepared for grafting with locally applied urea-sulfanilamide, fifteen split-thickness grafts were used. There was a 98 to 100 per cent "take" in twelve of the grafts, and an 88 to 90 per cent "take" in the remaining three grafts. Although we have not studied the comparative efficacy of topically applied urea-sulfanilamide and of penicillin in the preparation for grafting of frankly infected skin defects, it is interesting to note that the results we have observed with urea-sulfanilamide seem equally as good as those described by Hirshfeld and associates<sup>10</sup> in their report of the value of parenterally administered penicillin in the pre-grafting management of similar lesions. These investigators noted a 90 to 100 per cent "take" in eighteen and an 80 per cent "take" in only one of a total of nineteen split-thickness grafts,

following preliminary intramuscular administration of penicillin.

In our cases of externally draining lung abscess and empyema, the thick, foul,

cluding in some instances systemic and local chemotherapy with sulfonamides—we arrived at what seemed a conservative and reasonably correct appraisal of urea-



FIG. 1. A, F. O., a student nurse, fainted while ironing. The hot electric iron fell on the left side of her face producing a deep burn 6 by 9 cm. in area, in which there was complete destruction of tissue down to the facial muscles. After nineteen days of local treatment with wet dressings and following débridement the wound still showed considerable slough and abundant growth of *Staphylococcus aureus* and *Streptococcus hemolyticus*. Local treatment with urea-sulfanilamide was then begun and the photo above was taken several days later. B, the excellent end result obtained with grafting is illustrated. A split graft,  $2\frac{2}{1000}$  inch in thickness, was used twelve days after start of local applications of urea-sulfanilamide with a 100 per cent "take" and primary healing. The success of a free graft of this thickness is considered most unusual and can be ascribed largely to the virtual sterility of the wound at the time of grafting. No organisms could be cultured from the wound after one week of topical treatment with urea-sulfanilamide.

purulent exudate rapidly became serous under treatment with urea-sulfanilamide and, in all cases save one (Case 21), the wounds filled completely from below with clean granulation. Sinus tracts were kept open until healed by daily dressing, insufflation of the powder into the depths of the tracts, and loose packing with dry gauze.

In many of our group of cases classified as "Miscellaneous Surgical Infections," accurate evaluation of urea-sulfanilamide has been difficult. However, on the basis of past experience and because many of these cases had not responded favorably to any other method of treatment—in-

sulfanilamide in each case of this group, as noted in Table 1.

*Local Use of Urea-Sulfanilamide in Suppurative Peritonitis.* When a sulfonamide powder is implanted into a grossly infected peritoneal cavity, its antibacterial effect is undoubtedly largely inhibited by sulfonamide-antagonists in the purulent exudate which cannot be completely evacuated. However, it seemed that urea-sulfanilamide might be used advantageously in the local management of suppurative peritonitis, since the urea could reasonably be expected to counteract sulfonamide-antagonists present in the residual peritoneal pus. Because of this protective

effect of urea on sulfanilamide, it was logical to assume that, if urea-sulfanilamide was to be used intraperitoneally, less intensive efforts might properly be made

2.5 to 5 Gm. of sulfanilamide) were insufflated into the peritoneal cavity of each patient. Blood levels of free sulfonamide were determined at intervals through-



FIG. 2. A, E. I., aged six, sustained an extensive third degree burn of his left leg and thigh. After two weeks' local treatment with 1 per cent sulfanilamide solution, the wound still contained considerable slough and discharged a moderate amount of foul exudate. Wound cultures demonstrated pure growth of *Staphylococcus aureus*. The photo above was taken at this time and topical treatment with urea-sulfanilamide was begun.

at operation to remove *all* peritoneal pus, and the abdominal viscera, thus, would be spared much undesired but otherwise necessary manipulation.

Urea-sulfanilamide implanted into the normal peritoneal cavity of rabbits has been demonstrated to be grossly and histologically innocuous but in the same study<sup>11</sup> it was also observed that the solubilizing effect of urea on sulfanilamide caused the latter to be absorbed so rapidly from the animal's normal serosal surface that a high concentration of sulfanilamide *in situ* could at best be only transient.

Nevertheless, in several cases of suppurative peritonitis, one (Case 60) of which is listed in Table I, we endeavored to evaluate the clinical use of intraperitoneally implanted urea-sulfanilamide and simultaneously to determine the rate at which the sulfonamide component of the mixture is absorbed from the grossly infected peritoneum. At operation, 10 to 20 Gm. of urea-sulfanilamide (representing

out forty-eight hours following the intraperitoneal application of the mixture. The maximal and minimal rates of sulfonamide absorption observed in our cases are shown in Table III.

The rate of sulfonamide absorption following topical application of urea-sulfanilamide mixture in suppurative peritonitis is apparently sufficiently prolonged to allow the mixture to exert a definite local chemotherapeutic effect. The highly satisfactory postoperative course observed in each case of peritonitis in which urea-sulfanilamide was used intraperitoneally can be attributed in good measure, we believe, to the local efficacy of the drug mixture.

#### SULFONAMIDE-RESISTANT CASES

Of those infections which were clinically regarded as sulfonamide-resistant,—on the basis of lack of response to previous local or systemic therapy with sulfonamides,—



FIG. 2. B, two weeks after start of local treatment with urea-sulfanilamide the wound was devoid of slough and had healthy granulations throughout its area. The bacterial count had markedly decreased and the large skin defect was split-grafted in three stages with a 98 per cent "take." There was no contracture. The photo above was taken about one month after grafting.

four cases\* were selected for *in vitro* study of predominant pathogens isolated from the wounds. The object of such study was to demonstrate whether the apparent sulfonamide-resistance of these bacteria *in vivo* could be duplicated *in vitro* and whether the cultured organisms would be found to be readily susceptible to urea-sulfanilamide.

Each of the four isolated organisms\* was shown to grow without demonstrable inhibition in the presence of concentrations of sulfanilamide that far exceeded the concentrations which caused complete growth-inhibition of known sulfonamide-susceptible bacteria. The degree of *in vitro* sulfonamide-resistance varied among the four pathogens, *Staphylococcus aureus* (Case 19) proving most and pneumococcus (Case 20) least resistant. A sulfanilamide concentration of 200 mg. per cent failed to inhibit completely the growth of these organisms, except in the case of pneumococcus which was completely inhibited by a drug concentration of 170 mg. per cent. However, in the presence of amounts of urea sufficient to produce only very slight growth-inhibition, concentrations of sulfanilamide ranging from 10 to 30 mg. per cent caused complete growth suppression of all four organisms.

It was concluded, therefore, that these bacteria possessed varying degrees of sulfonamide-resistance which could be counteracted, through some unexplained mechanism, by adequate local concentrations of urea. That the bacterial strains represented by these organisms were susceptible *in vivo* to urea-sulfanilamide was apparent in the progressive decline of the wound flora and the gratifying chemotherapeutic results in the cases from which the organisms had been isolated, as noted in Table 1.

\* Cases 3, 5, 19 and 20 from which the following predominant pathogens were respectively isolated: *Clostridium welchii*, anaerobic streptococcus, *Staphylococcus aureus*, pneumococcus (Type xxiii).

## COMMENT

As urea-sulfanilamide comes in contact with a purulent exudate, it rapidly goes into solution. As long as the wound discharge is profuse, a dry sterile dressing is best used after insufflation of the mixture into the wound. Local edema rapidly subsides and the amount of wound exudate greatly decreases within a few days. At this point it has been found advisable to employ dressings soaked in saline instead of dry gauze dressings. Saline dressings prevent dryness and crusting of the non-discharging wound and do not impede local absorption of the mixture.

As wound edema subsides, it seems that early vascularization occurs and granulation progresses more rapidly than usual. When healthy granulations have appeared and wound discharge is scant, much smaller amounts of insufflated urea-sulfanilamide suffice and do not retard epithelization as larger quantities of the mixture are likely to do at this stage of treatment. In the pre-grafting preparation of infected skin defects, however, generous quantities of urea-sulfanilamide may be topically applied up to the time of grafting.

In none of the cases studied, have we observed any reaction that could be construed as a manifestation of local or systemic toxicity to urea-sulfanilamide. No significantly abnormal findings, attributable to the use of the mixture, have been demonstrated in frequent hematologic and urinary studies throughout treatment.

## SUMMARY

1. Evaluation of local treatment with a sterile urea-sulfanilamide mixture has been attempted in sixty cases of established surgical infections, most of which were chronic.

2. Plastic insufflator tubes, in which the sterile drug mixture was supplied, permitted uniform distribution of the mixture to surface wounds and facilitated its

application into large sinus tracts and wound recesses.

3. Therapeutic response was impressive in the majority of cases, including infections that had previously failed to respond to treatment with sulfonamides alone. Clinical improvement was corroborated by progressive, sometimes rapid, decrease in bacterial populations of the wounds.

4. In suppurative peritonitis urea-sulfanilamide, intraperitoneally applied at operation, was absorbed at a rate sufficiently slow to allow the mixture to exert a local chemotherapeutic effect.

5. Four cases in which the infecting organisms appeared to be sulfonamide-resistant responded favorably to treatment with urea-sulfanilamide. Predominant pathogens, isolated from the wounds in these cases, showed varying degrees of sulfonamide-resistance *in vitro* but were completely inhibited by urea-sulfanilamide in concentrations at which each drug alone was ineffectual.

6. No evidence of local or systemic toxicity to topically applied urea-sulfanilamide was observed in any of the cases studied.

7. Sterile urea-sulfanilamide has been found to be an efficacious local chemotherapeutic agent for septic wounds. Its rapid removal of slough from necrotic lesions and its non-toxic, antibacterial activity even in the presence of much purulent exudate and devitalized tissue are advantages well worth emphasizing.

The authors gratefully acknowledge the cooperation of the Clinical and Laboratory Staffs of Worcester City Hospital, Worcester, Mass., in carrying on this study.

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*It is only by the early use of skin grafting that contractures can be prevented in extensive total skin-loss burn cases.*

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams & Wilkins Company).

# LIGATION OF A SUPERNUMERARY URETER\*

## CLINICAL AND EXPERIMENTAL STUDY

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**I**NTENTIONAL ligation of an ureter without performing a nephrectomy is rarely ever performed excepting in experimental work. Intentional ligation of a supernumerary ureter without performing a heminephrectomy is the subject of discussion in this paper.

Experimentally, Francesco De Victorius-Medor<sup>1</sup> recently reported on early atrophy of the kidney without hydronephrosis following ligation of the ureter. It is interesting to note but not explained in his report of thirty-five experiments why only two terminated in atrophy while the others showed hydronephrosis.

Reference in this same article is made to many other investigators such as Bachrach, Frank and Glass who claim that early atrophy of the kidney results in every case of ligation of the ureter, whereas others like Delbert and Pepper claim that atrophy does occur frequently. It is further stated in the article that Scott, Albarran, Boemingham and others always obtain primary hydronephrosis and not atrophy after ligation of the ureter in animals.

Inasmuch as we were interested in what happens to a human kidney after a supernumerary ureter is intentionally ligated, we carried out some animal experiments for comparative studies.

It has been our experience in our experimental work on dogs, that hydronephrosis results first from ligation of the ureter and that atrophy must be secondary since none of our cases demonstrated an early atrophy.

It is a well recognized fact that the supernumerary fused kidney frequently

suffers pathological changes. We have encountered many cases of supernumerary fused kidneys with two ureters and have reported on seven bilateral cases.<sup>2</sup> We have always found that in the supernumerary fused kidney the upper segment was the least developed and when pathological changes did occur they occurred principally in this segment. In a number of instances we have seen the pathological condition in the lower segment as well.

We became interested in patients who had pain and discomfort thought to be renal in origin but were found to have non-pathological supernumerary fused kidneys and in whom there was no improvement from any type of treatment.

In the past eight years, we selected three such patients for study, two of whom had unilateral and one bilateral supernumerary fused kidneys. After a careful study we concluded that since there was insufficient reason for performing a heminephrectomy in a non-pathological uninfected supernumerary fused kidney that we would perform a ligation of the supernumerary ureter which is a less hazardous procedure, in an effort to relieve the patients of their discomfort.

By doing this we hoped that ultimately atrophy would result in the supernumerary segment and, if the discomfort was caused by the supernumerary kidney, that relief would be obtained. The work was purely experimental and of scientific interest to us and was fully explained to the patients.

Four clinical cases plus our experimental work forms the basis of our report and we

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present it for consideration. A brief review of the cases is as follows:

#### CASE REPORTS

CASE 1. V. D. E., twenty-one, a female, single, stenographer, was first seen on June 18,

cent from the left lower segment and 12.5 per cent from the right kidney.

The diagnosis was complete reduplication of the urinary tract on the left, with a fused supernumerary kidney, supernumerary ureter, and ureteral orifice.

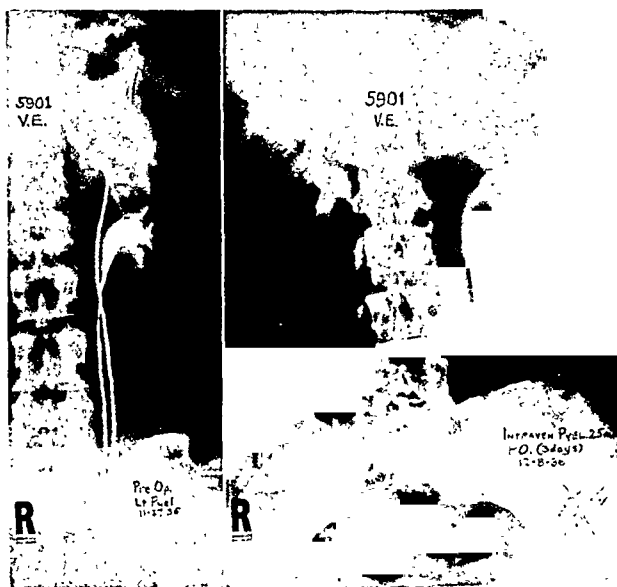


FIG. 1.

FIG. 2.

FIG. 1. CASE 1. V. D. E. Left supernumerary fused kidney; left retrograde pyelogram November 27, 1936.

FIG. 2. CASE 1. V. D. E. Intravenous pyelogram December 17, 1936, twenty days after ligation of left ureter leading to upper segment; no dye in upper segment.

1936. Her complaint was pain in the left lumbar region which she had experienced intermittently for about nine months. For the last two months the pain had been constant. During some of her attacks, she had had chills and fever causing her to remain in bed. She had urinary frequency also during these attacks. Her family, past, and menstrual history were unimportant.

In the examination, the left kidney was definitely palpable, with tenderness in the left flank. Her urine was uninfected. The positive findings on cystoscopy and pyelography revealed a left supernumerary fused kidney, two left ureters and two left ureteral orifices. The upper pelvis and calyces were the least developed of the two. The capacity of the left upper pelvis was 5 cc, while that of the lower was 10 cc. (Fig. 1.)

The phenosulphonphthalein test showed 10 per cent from the left upper segment, 10 per

After several dilatations of the left ureters, the patient obtained no improvement, so ligation of the supernumerary ureter was suggested. Six months later the supernumerary ureter was ligated in its mid-portion. Forty-eight hours after the operation the patient claimed she felt better and did not have any pain. During her stay in the hospital she was relieved of all her pain. She remained free from this symptom until she started working, when she developed some pain which she described as being different in character. This finally disappeared.

During her stay in the hospital intravenous pyelograms were made twenty days after the operation. (Fig. 2.) These showed bilateral normal pelves and calyces with no solution in the supernumerary kidney or ureter. On June 2, 1938, a relative phenosulphonphthalein test was made, and this showed 12.5 per cent from the right kidney and 18 per cent from the left

kidney in fifteen minutes. When last heard from (May 15, 1944) which was seven years after her operation she claimed she was free from pain and is now attending a nursing school.

CASE II. C. K., thirty-eight years of age,

The capacities of the kidneys were: Right upper segment 3 cc.; right lower segment 9 cc.; left upper segment 3 cc.; left lower segment 10 cc.

The phenolsulphonphthalein test revealed: The right upper segment, first fifteen minutes



FIG. 3. CASE II. C. K. Bilateral retrograde pyelogram August 14, 1934.

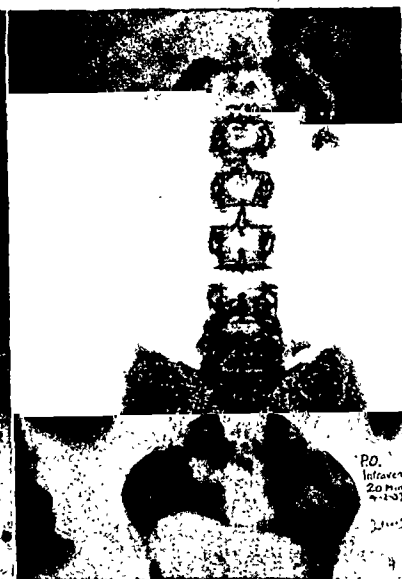


FIG. 4. CASE II. C. K. Intravenous pyelogram April 2, 1937. Ligation of supernumerary ureter, right, March 19, 1937; no dye in upper right segment.

married, a female housewife, was first seen August 14, 1934. Her complaint was pain in the left lower abdominal quadrant. She had this pain off and on for five years. In addition to the pain in the lower quadrant she had pain in the upper quadrant. It was of an intermittent type, sometimes being sharp, other times dull. Associated with the pain was urinary frequency, pain on voiding, some suprapubic discomfort, some nausea, but no chills or fever. Her past history was of importance in that she had an ovary removed for pain in her left abdomen and her appendix removed for pain in the right abdomen. She was nervous most of the time.

In the examination, both kidneys were palpable and appeared enlarged on the plain roentgenogram. She was tender in both the upper and lower left quadrant, with some tenderness in the left flank. Her urine was uninfected. On cystoscopy the positive findings were two ureteral orifices on each side. Catheters passed up all four ureters but encountered a definite obstruction in the ureter leading to the upper pelvis on each side. This was overcome. Urine from each kidney was uninfected.

8 per cent—right lower segment 6 per cent; the left upper segment, first fifteen minutes 7 per cent—left lower segment 7.5 per cent.

Bilateral retrograde pyelograms revealed that the upper pelvis of each segment was small and of the rudimentary type, whereas the lower pelvis and calyces of each segment were of normal size and well formed. Both double kidneys were of the fused type. (Fig. 3.)

The diagnosis was bilateral supernumerary fused kidneys with complete reduplication of the ureters and ureteral orifices.

Ureteral dilatations were given on numerous occasions with temporary relief. She began developing similar pains in her right side. During one of her severe attacks she was taken to the hospital.

On March 19, 1937, about thirty months after the original examination, a ligation of the right supernumerary ureter was performed. Almost immediately she was relieved of pain which did not return. Fourteen days after the operation, an intravenous pyelogram was made

which showed no dye in the upper pelvis of the right kidney. The lower pelvis and calyces on the right were normal. There were no changes

size and shape. Seventeen days after the operation she was discharged from the hospital. Eight months after the last operation a relative

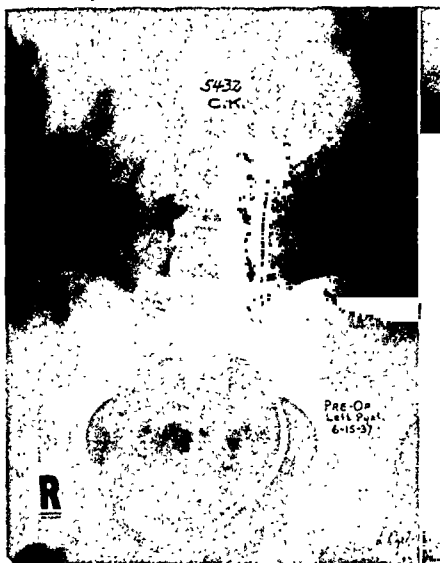


FIG. 5. CASE III. C. K. Left retrograde pyelogram June 15, 1937.



FIG. 6. CASE III. C. K. Left ureteral ligation October 5, 1937; intravenous pyelogram October 15, 1937; no dye in either upper segment.

in the pyelograms of the left double kidney. (Fig. 4.)

A postoperative relative phenosulphonphthalein test showed 10 per cent of phthalein in fifteen minutes from the remaining right kidney against 17.5 per cent from both left kidneys.

CASE III. C. K., forty-one years old, married, a female housewife, was the same patient as in Case II. While her first complaint was pain on the left side, her first operation was on the right kidney. For the past seven months her pain on the left became worse and since she had obtained so much relief from the operation on the right kidney, she finally insisted upon an operation on the left kidney. The pyelograms of the left were the same as on previous occasions. (Fig. 5.)

The relative phenosulphonphthalein test showed 18 per cent from the right kidney, 7.5 per cent from the lower left segment and 7 per cent from the upper left segment.

On October 5, 1937, a ligation of the supernumerary left ureter was performed, the same as was done on the right.

Three days after the operation her pain ceased and she has not had any since. Ten days after the operation, an intravenous pyelogram was made and this showed no dye in either supernumerary portion of the kidney. (Fig. 6.) The lower pelves and calyces were normal in

phenosulphonphthalein test was given and this showed 17 per cent from the right kidney and 15 per cent from the left kidney. She was free from pain and felt better than she had in eight years.

The last time she was seen was, March 4, 1944; which was seven years after the first ligation and six and one-half years after the second ligation. She claimed that she was free from pain.

CASE IV. L. W., forty years of age, a female married housewife, was first seen February 15, 1937. The complaint was pain in the left side and back. Her family, past, and menstrual history were unimportant. For a year she has had a dull ache in the left flank, radiating sometimes to the left lower quadrant. This pain was intermittent and was worse on standing. During this time she had had urinary frequency, and suprapubic discomfort, but no nausea, chills or fever. She was a rather nervous type of individual.

In the examination, the left kidney was palpable. There was tenderness in the left lumbar region and some tenderness also in upper left abdominal region. Her urine was uninfected. A plain roentgenogram showed a long, high left kidney.

On cystoscopy, two ureteral orifices were found on the left. The ureteral orifice leading to the upper left segment was pin-point in size

A postoperative (two months) phenosulphonphthalein test showed 19 per cent from the right kidney in fifteen minutes and 20 per cent

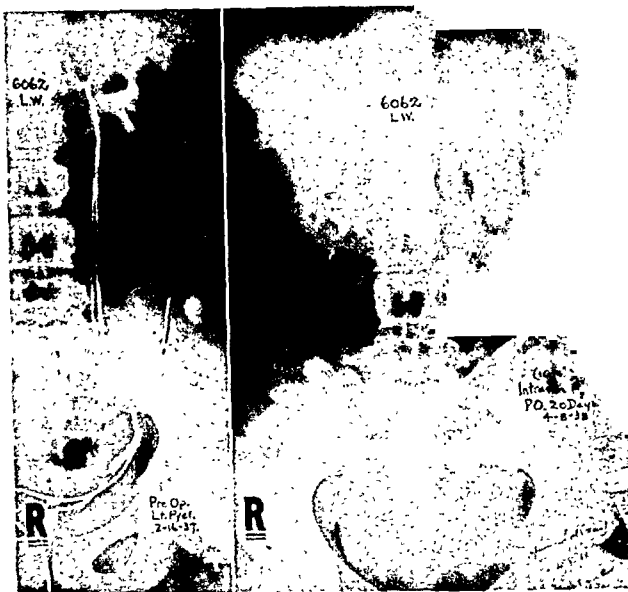


FIG. 7.

FIG. 8.

FIG. 7. CASE IV. L. W. Left retrograde pyelogram.

FIG. 8. CASE IV. L. W. Ligation of upper left segment March 18, 1938; intravenous pyelogram April 8, 1938; no dye in upper left segment.

and very difficult to enter. After many attempts a small catheter passed up this ureter. Urine from both left segments was free from infection. The capacity of the upper left segment was 5 cc. The capacity of the lower left segment was 8 cc.

The phenosulphonphthalein test showed 7 per cent from the upper left segment in fifteen minutes, 11 per cent from the lower left segment and 17 per cent from the right kidney in the same length of time.

Left retrograde pyelograms revealed a fused supernumerary kidney with supernumerary ureters and ureteral orifices. The supernumerary portion (upper) was not well developed. (Fig. 7.)

The diagnosis was fused supernumerary left kidney with supernumerary left ureter and ureteral orifice.

On March 18, 1938, a ligation of the left supernumerary ureter was performed. The patient was relieved of pain in three days. Twenty-one days after operation, an intravenous pyelogram was made and this showed no dye in the supernumerary portion (upper) of left kidney. There was some dye in the lower left kidney and in the right kidney. (Fig. 8.)

from the left kidney in the same length of time.

Since the operation, she has had a slight discomfort in the left lumbar region but she claimed it was a different type of discomfort. When last seen on April 6, 1944, which was six years after the ligation, she claimed that she was free from pain.

#### CLINICAL MATERIAL

The clinical application of ligation of a supernumerary ureter was used by us in four cases on three private patients, one patient having the operation performed bilaterally because of pain in bilateral supernumerary fused kidneys. The operation in all the cases was performed because of pain either in the lumbar or abdominal region. In three cases the discomfort and pain was on the left side, whereas in one, it was bilateral. The pain had been present between six months and seven years. It was intermittent at first but later became constant in all the cases and although not sharp, was very acute in two cases, simulat-

ing either a kidney colic or Dietl's crisis. Activity seemed to increase the pain. None of the patients showed any evidence of infection either by the presence of pus or organisms. All the patients were females under forty years of age, one having borne children whereas, the other two had not. Two of the three patients were married.

Functional studies revealed a good output in the opposite kidney, as well as a good excretion in the lower normal segment. The function of the supernumerary or upper segment was found to be fair. The capacities of the pelves of the upper segments were less than the lower ones, ranging between 3 and 5 cc.

The pyelographic studies were made both by the intravenous and retrograde method, and it was observed in all the cases that the pelves and the calyces of the upper segments were smaller than the pelves and calyces of the lower ones. A reproduction of the pain was obtained in all the cases by injecting the supernumerary segment with water.

Numerous dilatations, first of the supernumerary ureter, and then of the other ureter on the same side was performed in all the cases. The number of dilatations of the supernumerary ureter varied from three to twelve. In one case the supernumerary ureter presented a real stricture at the orifice. In the other cases a No. 6 catheter met a slight obstruction which was easily overcome. None of the cases showed a dilatation of the supernumerary ureter.

The emptying time seemed to be normal (four to eight minutes) in all the supernumerary segments.

All the patients seemed to be of a nervous type. Gynecological, orthopedic, and psychiatric examinations were made on all patients. In only one case was there a question of a psychiatric problem.

#### EXPERIMENTAL MATERIAL

In an effort to observe what happens to the kidney after the ureter is ligated one

ureter of each of eight dogs was ligated and cut. While we were unable to ligate supernumerary ureters in the dog, we were able to study the condition of the kidney after one ureter was ligated. As near as possible the studies were made along the lines similar to those made on the human. These studies included the notation of the size of the preoperative and postoperative kidney. The functional studies of the kidneys were made after the complete ligation of the ureter by studying the urinary output of the kidney and by studying the kidney pelves and calyces after intravenous pyelography. In reality this latter method is a functional study because it is dependent upon the work of the excretory apparatus of the kidney. Retrograde pyelography was also performed so that comparisons could be made with those of intravenous pyelography as well as to determine whether hydronephrosis takes place with or without atrophy of the kidney and when it occurs.

These studies were made at various intervals ranging from one hour to thirteen days after ligation of the ureter.

#### OPERATIVE TECHNIC IN CLINICAL CASES

Previous to the operation a catheter was placed in the supernumerary ureter. The ureter was exposed extraperitoneally through a Gibson incision. The mid-third of the ureter was selected for the ligation. After the ureter had been freed for a short distance, three chromic catgut ties were placed around the ureter about  $\frac{1}{2}$  cm. apart. The ureter was cut so that two of the ties were left on the lower portion and one on the upper portion of the ureter. A small portion of the ureter was removed for examination. The upper portion of the ureter was observed for a few moments but no great perceptible dilatation of the ureter occurred. No leakage of urine resulted from the operation so that the wound was closed without drainage. The operating time varied between twenty-five and thirty-five minutes. Avertin anesthesia was used in the four operations.

# OPERATIVE TECHNIC IN EXPERIMENTAL WORK

Since the dogs did not have supernumerary ureters, it was not necessary to place catheters into the ureters. The dogs

From 3 to 4 cc. of nembutal were injected intravenously before the operation, and ether was used during the operation.

Eight dogs were operated upon fourteen times for the experiments.



FIG. 9. Dog 7. Intravenous pyelogram one hour after right ureteral ligation; no dye on right.



FIG. 10. Dog 8. Intravenous pyelogram one day after right ureteral ligation; no dye on right.

weighed between 12 and 20 pounds and were between one and three years of age. Soap and water and iodine technic was used. The right kidney and ureter was selected for the experimental work. The kidney and ureter was exposed through a transperitoneal operation in all of the cases. In most of the cases the post peritoneum was opened to expose the kidney and ureter. Two catgut ties were made in the mid-third of the ureter and was cut between them. No leakage of urine resulted. The post peritoneum when opened was not closed in any of the cases. The peritoneum, muscles, fascia and skin were separately sutured with continuous plain catgut. The upper portion of the ureter was sutured underneath the skin so that further studies could be made. No drainage was established in any of the cases. Collodion dressings were applied.

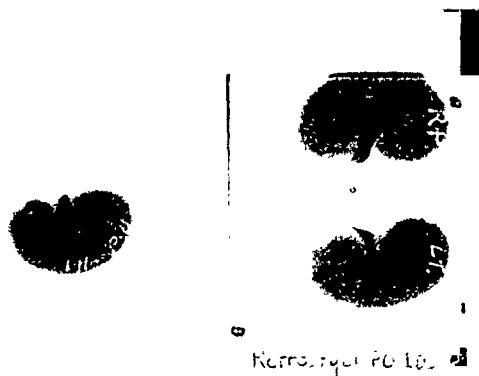


FIG. 11.

FIG. 11. Dog. 7. One hour postoperatively; retrograde pyelogram of removed kidney whose ureter was ligated; slight dilatation of pelvis and calyces.

FIG. 12.

FIG. 12. Dog. 8. One day postoperatively; retrograde pyelogram of both kidneys; right side, ureter ligated; left side, not ligated; more dilatation in right kidney than left kidney.

PREOPERATIVE AND POSTOPERATIVE STUDIES  
IN CLINICAL CASES

Both preoperatively and postoperatively the urine was free from pus and organisms. The urine functioned at the same rate postoperatively from the remaining kidney as it did preoperatively.

The phenosulphonphthalein tests revealed the following per cents in fifteen minutes.

|                                      | Preop-<br>erative | Postoperative           |
|--------------------------------------|-------------------|-------------------------|
| Case I—Rt. kidney . . . . .          | 12.5              | 12.5                    |
| Lt. lower segment . . . . .          | 10                | 18                      |
| (Sup. *) Lt. upper segment . . . . . | 10                | None, operative<br>side |
| Case II—Rt. lower segment . . . . .  | 6                 | 14                      |
| (Sup.) Rt. upper segment . . . . .   | 8                 | None, operative<br>side |
| combined Lt. kidney . . . . .        | 14.5              | 16                      |
| Case III—Rt. kidney . . . . .        | 18                | 17                      |
| Lt. lower segment . . . . .          | 7.5               | 15                      |
| (Sup.) Lt. upper segment . . . . .   | 7                 | None, operative<br>side |
| Case IV—Rt. kidney . . . . .         | 17                | 19                      |
| Lt. lower segment . . . . .          | 7                 | 20                      |
| (Sup.) Lt. upper segment . . . . .   | 11                | None, operative<br>side |

\* Supernumerary.

The studies of the capacities (in cc.) of the kidneys were as follows:

|                                      | Preop-<br>erative | Postoperative           |
|--------------------------------------|-------------------|-------------------------|
| Case I—Rt. kidney . . . . .          | 10                | 10                      |
| Lt. lower segment . . . . .          | 10                | 10                      |
| (Sup. *) Lt. upper segment . . . . . | 5                 | None, operative<br>side |
| Case II—Rt. lower segment . . . . .  | 9                 | 9                       |
| (Sup.) Rt. upper segment . . . . .   | 3                 | None, operative<br>side |
| Lt. lower segment . . . . .          | 10                | 10                      |
| (Sup.) Lt. upper segment . . . . .   | 3                 | 3                       |
| Case III—Rt. kidney . . . . .        | 9                 | 9                       |
| Lt. lower segment . . . . .          | 10                | 10                      |
| (Sup.) Lt. upper segment . . . . .   | 3                 | None, operative<br>side |
| Case IV—Rt. kidney . . . . .         | 8                 | 8                       |
| Lt. lower segment . . . . .          | 8                 | 9                       |
| (Sup.) Lt. upper segment . . . . .   | 5                 | None, operative<br>side |

\* Supernumerary.

The pyelographic studies in the clinical cases were made by the retrograde method preoperatively and the intravenous method postoperatively. The purpose of the intravenous method postoperatively was to study if possible the function and to visualize the kidney whose ureter was ligated. We were also able to visualize and study the pelvis of the other portion of the double kidney and to visualize the kidney on the opposite side.

In these studies we always found the upper segment to have the smaller pelvis, varying from 3 to 5 cc. in capacity, while the other pelvis was the larger, varying from 7 to 10 cc.

The postoperative studies demonstrated that no solution appeared at any time in the kidney whose ureter was ligated, while the other pelvis and calyces on both sides demonstrated its appearance in five to fifteen minutes, showing no dilatation following the operation. The kidney of the ligated ureter was studied as early as three days and as late as sixty days postoperatively.

PREOPERATIVE AND POSTOPERATIVE  
STUDIES IN THE DOGS

The preoperative studies on the dogs were simply to note the condition of the kidney and ureter as to infection and size. None of the dogs had any infection either before or after the ligation. The kidneys were measured before and after the ureter was ligated. The change in the size of the kidney depended upon the length of time that had elapsed after the ligation of the ureter. The kidneys and ureters were studied, one hour, twenty-four hours, three, six, ten, and thirteen days after the ligation. The kidney increased in size in all dimensions, the longer the time elapsed after the ligation of the ureter. This increase varied from 1/2 to 2 cm. in length in the dog's kidney, three days after the ligation and continued on to increase in size up to thirteen days after ligation of the ureter. This was the longest time that the dogs' kidneys were studied in these

experiments. The kidney of the dog, one and twenty-four hours after ligation showed no increase in size.

ureter; the longer after the ligation, the thinner the cortex became. (Figs. 11 to 14.)



FIG. 13. Dogs 5 and 6. Three and six days postoperatively showing definite dilatation of the pelvis and calyces, more in the dog of sixth postoperative day (6) than in the dog of third postoperative day (5).



FIG. 14. Dogs 3 and 1. Ten and thirteen days postoperatively; retrograde pyelogram showing definite dilatation of the pelvis and calyces, less in the ten day postoperative dog (3) than in the thirteen day postoperative dog (1).

After the ligation of the ureter, the pelvis and calyces increased progressively in size and the medullary and cortical tissues decreased. The longer the time after the ligation, the more marked were these changes.

The function of the dog's kidneys was studied postoperatively by intravenous pyelography. This demonstrated that no dye appeared in the kidney after the ureter was ligated in any of the dogs. This study was made from one hour up to three days after ligation. The dye did appear, however, in normal time in the opposite kidney. (Figs. 9 and 10.) This was the same finding as in our clinical cases. The kidney of the operated side was removed at the various intervals mentioned and studied pyelographically by the retrograde method.

After ligation of the ureter it was found that in all these kidneys the pelvis and calyces showed some evidence of hydronephrosis, even though very slight. No evidence of any atrophy was observed in any of the kidneys. (Figs. 11 to 14.)

The cortex and the medullary portion of the kidney was reduced in size depending upon the elapsed time of the ligation of the

In all the cases the microscopic picture shows evidence of good-functioning glomeruli decreasing in number as there was an increase in time that elapsed after the ligation of the ureter. This same picture was found throughout the sections relative to the other structures of the kidney.

#### POSTOPERATIVE COURSE IN PATIENTS

All the wounds closed by first intention. Peculiarly enough while the patient had some pain after the operation, which was the result of the operation, they all claimed it was of a different type. In all, the original type and location of pain seemed to have disappeared immediately after the operation.

Postoperative studies were made while the patients were in the hospital and after they were discharged.

In the hospital, total phthaleins were given to make comparisons with the total preoperative phthaleins, and it was found that little difference was found in any of the cases.

Pyelograms of the remaining kidneys were made by the intravenous route, making it in Case 1 in twenty days, in



Case II in fourteen days, in Case III in ten days, and in Case IV in three days.

In all the cases when the pyelograms were made it was observed that no dye came through the supernumerary segment but that the dye came through the other two kidneys in normal time and that the appearance of the remaining pelvis was the same as in the original retrograde pyelograms.

The patients were discharged in from twelve to twenty-one days.

Relative phthaleins were not made until after the patient left the hospital as is seen in the case histories.

#### POSTOPERATIVE COURSE IN THE DOGS

All but two dogs lived, and were kept under observation for other studies. In the two dogs that died one eviscerated after pulling his dressings off and the other died under the anesthetic. The wounds of the others healed by first intention and there was no evidence of peritonitis.

#### FOLLOW-UP COURSE

After the patients left the hospital, the urines were studied on various occasions and in no case had the urine become infected.

Relative phthaleins were made at various intervals from thirty to ninety days after discharge from the hospital. It was observed that in all the cases the phthalein of the remaining portion of the supernumerary kidney had increased in amount and remained so.

The pain, which was the chief complaint, had disappeared and in no case had it returned after seven years, which is the longest time of follow-up of the first case. One patient complained of a slight discomfort in the operative region, but claimed it was different in character.

#### COMMENT

In the discussion of this problem we believe that the pain probably originated

in the supernumerary segment and was due to an intermittent hydronephrosis which was caused by slight obstruction in the supernumerary ureter. Since the ureters were not completely obstructed, these patients had their pain only when urinary stasis existed in the supernumerary segment as is found frequently in renal colic or in Dietl's crisis. When this pelvis emptied, they were relieved of pain. We also know that cases of intermittent pyelectasis give more pain than those that have continued pyelectasis. The only reason that can be given for the relief of pain after ligating the supernumerary ureter in these patients is that a complete obstruction is produced, an early hydronephrosis results, gradually causing destruction to the functioning glomeruli with the quick and early result that a non-functioning renal segment is produced. As soon as the non-functioning segment is produced and is uninfected it causes no disturbance in the body. We have seen this only too frequently in our experience.

#### RESULTS IN CLINICAL CASES

From this study it has been observed that after an ureter is ligated and cut a hydronephrosis immediately starts. Although this never assumes a very large size, it is present. This is borne out by the experimental work on the dogs. Whether it goes on ultimately to atrophy, we are unable to state as we had not carried on our experiments for a sufficient length of time. From a functional standpoint, the urine ceases to secrete very shortly after ligation which was also borne out by the experimental work, so that when an intravenous pyelogram was made, no dye was found in the kidney pelvis or calyces. The earliest that this was demonstrated in the human was three days, whereas in the animal it was within one hour.

The pain appears to subside almost immediately after the ligation, although there was some ache in the lumbar region for about three months in two of the cases

but was described as a different type of pain. In all probability, this was a post-operative ache that may be encountered following any operation.

These cases have been followed from six to seven years.

In all the cases, the patients were able to return to their normal duties and accomplish them in a much better fashion than ever before.

#### CONCLUSIONS

1. Lumbar discomfort renal in origin, in the presence of an uninfected supernumerary renal segment, is relieved by permanent ligation of the supernumerary ureter.
2. The operation has been performed four times on three patients with good results.
3. All other methods of treatment should be tried first.
4. The function of the supernumerary segment ceases within several hours after the ligation of the ureter. This has been verified clinically by intravenous pyelography and supported experimentally on dogs.
5. The ultimate outcome of the supernumerary segment is a mild hydrone-

phrosis and then a non-functioning renal segment.

6. The function of the remaining kidney on the same side is undisturbed or improved, supported by a functional test of phenosulphonphthalein and intravenous pyelography in the human and dogs.

7. The remaining kidney does not become hydronephrotic, supported by intravenous and retrograde pyelographic observations on the human and dog.

8. Three patients upon whom the operation was performed four times (bilateral in one case) have been relieved for as long as seven years.

Our appreciation is extended to Dr. H. H. Spencer of the Pathological Department, and Dr. G. H. Yeager and Miss M. Hickman of the Experimental Operative Surgical Department of the University of Maryland, also to Miss A. Fishpaugh of the Roentgenological Department of the Sinai Hospital for their cooperation and valuable services rendered in the completion of this work.

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# INTERVERTEBRAL SPINE FUSION WITH REMOVAL OF HERNIATED INTERVERTEBRAL DISK\*

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THE symptoms due to herniation of an intervertebral disc, or discs, are relieved by removal of the herniated disc or discs sufficiently to have no recurrent herniation of the remaining portion. Theoretically, but not actually, the articular cartilages on the bodies of these two vertebrae then fuse, preventing motion at this spot. Actually this does not always happen. Even when the intervertebral space has been well cleansed of all nucleus and annulus that it is possible to remove, and a generous amount of the articular surfaces has been removed, ankylosis of the adjoining vertebral bodies frequently does not occur and there remains motion in this joint space. Besides this, the joint space may be greatly narrowed. Together with the narrowing of the space between the bodies of the vertebrae there occur changes in the region of the articular facets and intervertebral foramen. These consist of slight slipping of the articular facets, and narrowing of the intervertebral foramen.

The cause of persistent or recurring pain after intervertebral disc operations may be any one of the following: (1) Removal of the wrong disc, (2) removal of an insufficient number of herniated discs, (3) recurrence of the herniation when the intervertebral disc has been incompletely removed, (4) arthritis of slipping in the region of the articular facets in the area involved, and (5) narrowing of the intervertebral canal with nerve root pressure. It is with the last three causes that this paper is concerned. Removal of insufficient number of discs necessitates reoperation.

Recurrence or herniation of the remaining intervertebral disc, facet syndromes due to slipping or arthritis of the facets,

or root pressure syndromes with root pain due to narrowing of the intervertebral canal, can all be prevented by anticipating their occurrence and preventing such, by use of intervertebral bone grafts. We first began using intervertebral bone grafts approximately one year ago, after having operated upon two patients in succession for recurrence of the herniation. In both of these the posterior longitudinal ligament had a rather large opening in it, and the nucleus projected itself out through this opening. Removal of this remaining portion of the disc was comparatively simple after the approach to the disc through the adhesions was made. In order to prevent a recurrence we removed a portion of the spinous process of the vertebra involved, and after thoroughly curetting the cartilage from the adjacent vertebral bodies and cleansing this portion of the spinous process well, placed it through the opening in the posterior longitudinal ligament and then turned the graft sideways so that it could not extrude itself again. Both of these patients had uneventful recoveries and have been entirely free from symptoms ever since. It occurred to us that pain which we contributed to facet syndrome and root pain persisting after the operation could also be prevented by building up the joint space between the adjacent bodies of the vertebra and by fusing this space to prevent motion at this joint. This we have been doing for the past year according to the following technic, as illustrated in the following case reports:

## CASE REPORTS

CASE I. Mr. M. G. was injured when he fell through a hole between a truck and shipping

\* From the section on surgery the Lois Grunow Memorial Clinic, Phoenix, Arizona.

dock and struck his left ischial tuberosity on the loading deck. His subsequent course was characterized by limitation in motion of the spine, scoliosis, sciatic pains in the left leg and atrophy of the left thigh and calf. Myelograms revealed a left-sided defect at the lumbosacral space. At the time Mr. G. was operated upon he was nearly invalided. The operative report is as follows:

Incision was made over the lower lumbar and sacral spines. Hemostasis was secured with electrocoagulation and towels applied to the skin. Muscles were dissected free from the left side of the spinous process and the laminae. The lumbosacral area was well cleansed. Laminectomy retractors were inserted and the lower portion of the fifth lumbar lamina on the left was nibbled away. The ligamentum flavum was removed exposing the extradural fat which was also removed. The dura and exiting nerve root were retracted medially. The disc was exposed very well and presented itself as a 4 by 5 mm., pearly, hard cartilaginous tumor. A circular incision was made in the posterior longitudinal ligament and the nucleus pulposus ejected slightly. The nucleus was removed with curet and forceps. The cartilage on the inferior portion of the fifth lumbar body and superior portion of the sacrum was removed by thorough curetment. A small segment of the spinous process of the fifth lumbar vertebra was removed. This was approximately 10 by 4 by 3 mm. in size. The bone removed by rongueering away the lower portion of the fifth lamina on the left, and this oblong-shaped graft, was inserted into the intervertebral space. The segment removed from the spinous process was inserted lastly. The wound was thoroughly irrigated with saline and closed in the routine manner.

The patient left the hospital less than three weeks afterwards and since then has had no back pain, no sciatic pain and is now entirely free from his former marked scoliosis. X-rays taken ten weeks later showed, as yet, incomplete fusion of the lumbosacral joint space. The joint space is not narrowed.

CASE II. Mr. J. H. was injured when he was lifting a barrel of oil and slipped, coming down in a sitting position on a concrete floor. Following the accident he had persistent low back pain with sciatic distribution of pain in the left leg. He had slight atrophy of the left thigh and left calf. There was anesthesia over the anterior

and lateral portion of the left lower leg beginning about two inches below the knee and extending into the fourth and fifth toe. There was pain over the distribution of the sciatic nerve and the Achilles' reflex on the left was diminished. Oleomyelograms done with lipiodol on this patient revealed a filling defect between the third and fourth lumbar vertebra on the left.

The patient was operated upon as follows: The routine incision was made and the muscles stripped from the left side of the spinous processes and the lamina of the third, fourth, and fifth lumbar vertebra. The lower part of the fourth lumbar lamina on the left was then rongeured away, the ligamentum flavum removed, and the spinal canal entered. There was found a disc here which extruded slightly. The posterior longitudinal ligament was incised and a circular area removed from this structure. The herniated nucleus as well as the annulus fibrosis was removed with forceps and curet. The articular surfaces on the adjacent vertebral bodies were thoroughly curetted away. The entire left side of the fourth lamina was then removed and the third intervertebral space inspected. The third space was found to have a ligamentum flavum which was very thick with caseous appearing material in the area between the ligamentum flavum and extradural fat. This thickened, cheesy ligamentum flavum constricted the dura here and was removed entirely. Part of the spine of the fourth lumbar vertebra was removed in approaching this region. This portion of the spinous process, as well as the tiny fragments rongueured away when the lamina was removed, was inserted into the space between the fourth and fifth lumbar vertebra, thus doing a bone graft between the bodies of these vertebra with a previously prepared spinous process segment and lamina fragments. The area was inspected for hemostasis, a thorough search was made for sponges and none were found. A routine closure was used without drainage.

The patient left the hospital at the end of three weeks and has been entirely free from pain ever since. Recheck x-rays revealed new bone forming in the intervertebral space and the intervertebral space is not narrowed.

As yet our results are not permanent nor can the future course of events be anticipated, however, we can say that we have

not operated upon a single person and employed this technic without excellent results. All patients on whom we have done this type of operation, we have kept in bed for three weeks in a horizontal position. We then allowed the patient to be up without a brace and advised against excessive motion in the back. We advised against heavy lifting or stooping for a period of six months. All patients have returned to their homes, if they have lived outside the city; and from written reports all are doing well. The patients in the city we have observed and none have had any remission or any recurrence of symptoms.

#### SUMMARY

We have here presented a preliminary report of a method of spinal fusion following removal of the intervertebral disk. We also believe that if this method is followed that there will be no recurrence following incomplete removal of a herniated intervertebral disc. There will be no symptoms persisting due to slipping, or

arthritis, in the region of the articular facets. There will be no root pain persisting due to narrowing of the intervertebral foramen with root pressure. Even following the most thorough curettment, without bone grafting after the removal of an intervertebral disc, we find that fusion results in only a small number of cases, and we believe that this method will greatly increase the number of cases of fusion between the adjacent vertebra. This method appears to be the method of choice where laminectomy has been done previously for any reason whatsoever, and it is necessary to bridge a wide gap between the spinous processes. It seems that fusion between the bodies of the vertebra and at the facets is the method of choice here and should be employed. We believe that if intervertebral body fusion operation be employed along with the routine removal of herniated intervertebral disc, the number of patients who have symptoms persisting after operation will be appreciably lowered.



# FRACTURE OF THE ZYGOMATIC BONE AND ARCH POSTOPERATIVE HEADGEAR

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**F**RACTURE of the zygoma is a rare entity in ordinary life. It has been reported that the incidence of fracture of the malar bone and zygomatic arch is 1:3000 cases of fracture of bones of the face. In contrast to the paucity of cases in civil medical practice, I have had the occasion to treat five patients at Station Hospital in the short period of eight months. All of them were the result of direct impact against the cheek bone which temporarily disabled them. One case presented evidence of concussion. He also had diplopia, which cleared up prior to reduction, despite a depression of the orbital floor. Two other patients also had depression of the orbital floor but without diplopia. None of the cases were compounded. All of them revealed obvious deformity of the involved side of the face, and each was corrected by open reduction and returned to duty.

## ANATOMY

The zygoma, or malar bone is a small quadrangular bone which forms the prominence of the cheek, and part of the lateral wall and floor of the orbit. Its malar surface is convex anteriorly; its posterior or temporal surface is concave forming the anterior boundary of the temporal fossa above and the infratemporal fossa below. It articulates with the frontal, sphenoidal, temporal and maxillary bones by means of processes. Suture lines are present at these junctions between the frontal bone and the frontosphenoidal process of the zygoma; between the sphenoid and the orbital process of the zygoma; between the zygomatic process of the temporal bone and the temporal process of the zygoma; and between the maxilla and the maxillary

process of the zygoma. These suture lines are of importance since in the majority of instances, the zygoma separates at these serrated articulations and becomes depressed. The walls of the underlying maxillary antrum may thereby become fractured and the sinus encroached upon. The body of the bone *per se* is only infrequently fractured. In addition to the separation at the suture lines, the zygomatic arch which is part of the temporal bone may be fractured and crumpled by a sharp blow. The smallest part of the process near the temporal end is the common site of fracture. The masseter muscle takes origin from the inferior surface of the zygomatic arch. The temporal fascia inserts at its superior surface.

## DIAGNOSIS

The diagnosis of fracture of the zygoma and zygomatic arch is based upon the history, clinical and roentgenological findings. There is always the story of a direct blow or impact upon the cheek. The involved side of the face presents the characteristic loss of the prominence of the cheek bone with asymmetry of the two sides. Soft tissue swelling due to hemorrhage and edema may tend to obscure the diagnosis. Palpation, however, will reveal the depression of the zygomatic arch and of the orbital border if present. The roentgenograms will substantiate the clinical findings. The patient may have difficulty chewing due to spasm of the masseter muscle. In cases of depression of the orbital floor, diplopia may be present as well as infraorbital anesthesia. Unilateral epistaxis may be evident and there may be local ecchymosis as well as subconjunctival hemorrhage.

### COMPLICATIONS AND INDICATIONS FOR THERAPY

Fracture of the malar bone may be accompanied by complicating fracture of the

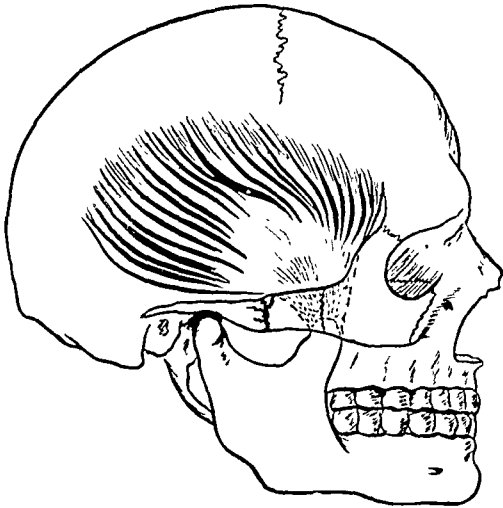


FIG. 1. Skull illustrating zygomatic suture lines; fracture of zygomatic process of temporal bone; relationship of temporalis muscle to zygomatic arch.

surrounding bones. The orbital surface of the maxilla, in addition to the orbital process of the zygoma, may be fractured and depressed, occasionally resulting in diplopia as the eyeball follows the orbital floor downward. The cause of diplopia and its significance require clarification. Broadly speaking, diplopia following a direct injury of the face and eye is due to an inability of the external ocular muscles to move the eye synchronously with the uninvolved eye. Hemorrhage and swelling into the orbital cavity may cause temporary exophthalmus with diplopia. Paralysis of one or more of the extrinsic ocular muscles may also be a cause. Depression of the orbital floor and eyeball may prevent the involved eye from focusing coordinately with the uninjured eye. Diplopia results. When diplopia exists in the presence of depression of the orbital floor, it has generally been credited directly to this depression in the past. Accordingly, immediate open reductions have been performed with surgical approaches through the buccal or nasal cavity and through the antrum,

often resulting in serious, complicating infections. The depressed floor is reduced but many times incompletely. Yet the diplopia seems to disappear in most instances regardless of the degree of reduction. In view of this, I wonder whether the usual mild to moderate degree of depression of the orbital floor is the actual cause of diplopia? If the answer is doubtful does the hazard of developing an infection and chronic sinusitis warrant such an immediate operative approach? Is it not possible that most cases of diplopia are not directly associated with the depressed orbital floor? Three of the cases reported in this series had depressions of the orbital floor, yet only one had diplopia. Reduction was postponed in this case because of a concussion, and during the five days' delay the diplopia disappeared spontaneously. Had immediate reduction been performed, the operation would have been credited with correcting the diplopia. It is apparent in this case that hemorrhage and/or edema was the cause of the diplopia, and subsidence of the resulting swelling permitted normal accommodation. Delayed open operation in this case through an external potentially clean approach completely reduced the depressed zygomatic arch, but the depressed orbital floor remained unreduced. Yet diplopia did not recur, despite the fact that the orbital depression was fairly marked in degree.

It is therefore recommended that in cases of diplopia with depression of the orbital floor, any operative approach through the buccal or nasal cavity or antrum be delayed. Any of the other methods of reduction which avoid these areas may be carried out immediately, if the patient's general condition warrants; and they alone may reduce the orbital floor as well as the depressed zygomatic arch with complete correction of the diplopia. In that case the hazard of an operative approach through potentially infected tissue can be avoided. In two of the three cases in this series with depression of the orbital floor, almost complete reduction of the orbital floor was obtained along

with complete reduction of the arch by the Gillies method. The diplopia may disappear even though the orbital floor is

In those cases in which the fracture involves the orbital floor, especially where depression is present, the infraorbital

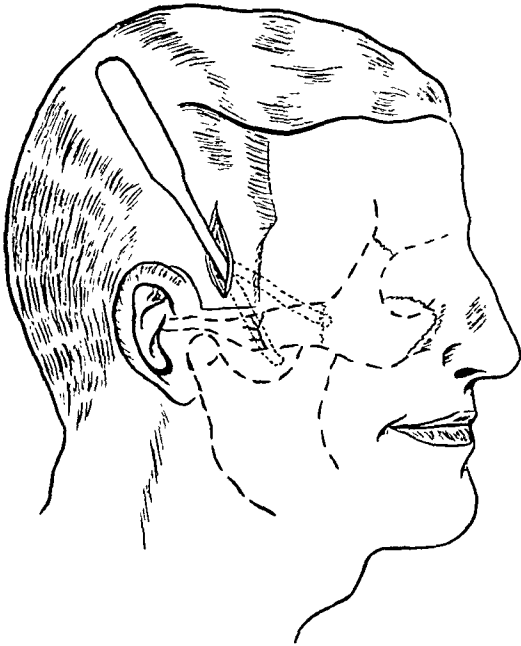


FIG. 2. Gillies temporal approach for reduction of fracture of zygomatic arch and depression of malar bone.

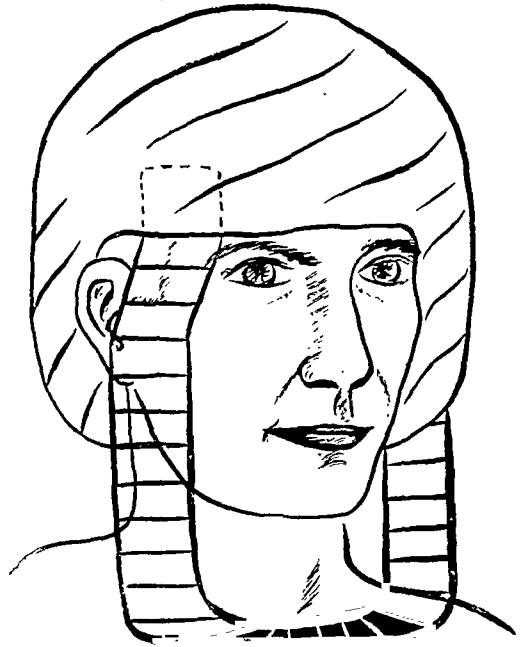


FIG. 3. Postoperative plaster of Paris headgear with wire ladder splint incorporated.

incompletely reduced or even unreduced. Unless the depression of the orbital floor is considerable, it does not appear to be a complicating factor functionally and therefore will probably not cause any disability in vision. The position of the eyeball will not change permanently unless the orbital contour is greatly altered. In those cases in which diplopia still persists, it will be necessary to reduce the orbital floor secondarily. Even then operative approaches which avoid the antrum and nasal cavity are preferable in order to prevent serious infection. The available methods will be discussed under therapy. The delay occasioned by originally avoiding the buccal, nasal or antral approach should not make reduction more difficult. In one of the cases in this series, reduction was performed thirteen days following injury without difficulty. A second case was reduced twelve days after injury without any undue effort.

nerve may be impinged upon either within its canal or at the infraorbital foramen. Neuroma formation may occur, necessitating excision of the nerve at its exit through the foramen in order to relieve the patient of pain. This, of course, results in anesthesia of the upper lip and a triangular area on the face below the eye with its apex at the foramen.

In complicated cases, the general condition of the patient influences the immediate course of therapy. Compound fractures require débridement and removal of foreign material in addition to reduction and immobilization of the fracture. In cases with complicating nasal fractures, hemorrhage may be sufficient to obstruct nasal breathing. Packing may be necessary to control bleeding and a tracheal tube passed through the mouth may be essential where the airway is obstructed. Tracheotomy may even be necessary.





FIG. 4. CASE 1. *Upper left:* Tangential view with depression of zygomatic arch, left. *Upper right:* Postero-anterior oblique view revealing fractures at zygomaticofrontal and zygomaticotemporal suture lines as well as depression of orbital floor. *Middle left:* Complete reduction of arch. *Middle right:* Practically complete reduction of orbital floor. *Lower left:* Composite view showing symmetry of arches bilaterally following reduction.

## TREATMENT

Reduction of fractures of the zygoma and zygomatic arch should be accom-

1. The sharp prongs of a towel clip are inserted percutaneously to grasp the depressed zygomatic arch for traction and



FIG. 5. CASE II. *Upper left:* Tangential view with depression of zygomatic arch, right. Note complete fracture at zygomaticotemporal suture line, as well as incomplete fracture through zygomatic process. *Upper right:* Postero-anterior oblique view. Note fractures at zygomaticofrontal and zygomaticotemporal suture lines with marked depression of arch; also mild depression of orbital floor and marked clouding of antrum. *Lower left:* Complete reduction of arch. *Lower right:* Practically complete reduction of orbital floor. Note reduction of zygomatic arch in this view.

plished as early as possible, just as in fractures elsewhere, and by the safest method available. Its purpose is to restore normal function of the mandible and eye and normal facial contour. Undue delay in reduction permits increased local soft tissue reaction and fixation of the displaced fractured fragments. In cases of persistent ocular changes, failure of reduction may cause these to become permanent.

The following is a brief description of the many methods of reduction that have been described:

reduction. In my experience, the strongest towel clip is not sturdy enough. It bends out of shape during traction and suddenly loses its grip on the bone causing a slight jagged tear in the skin.

2. Reduction may be accomplished by inserting a corkscrew through a small skin incision to the depressed bone for traction and manipulation according to the method of Roberts. Rarely is it necessary to employ a narrow chisel to loosen the line of fracture to permit elevation of the depressed bone.

3. In some old cases, it may be necessary to cut down on the fracture site and free it with an osteotome in order to obtain re-

into the zygoma through a small incision over the bone. By means of a plaster head cap, containing a side arm of heavy wire,

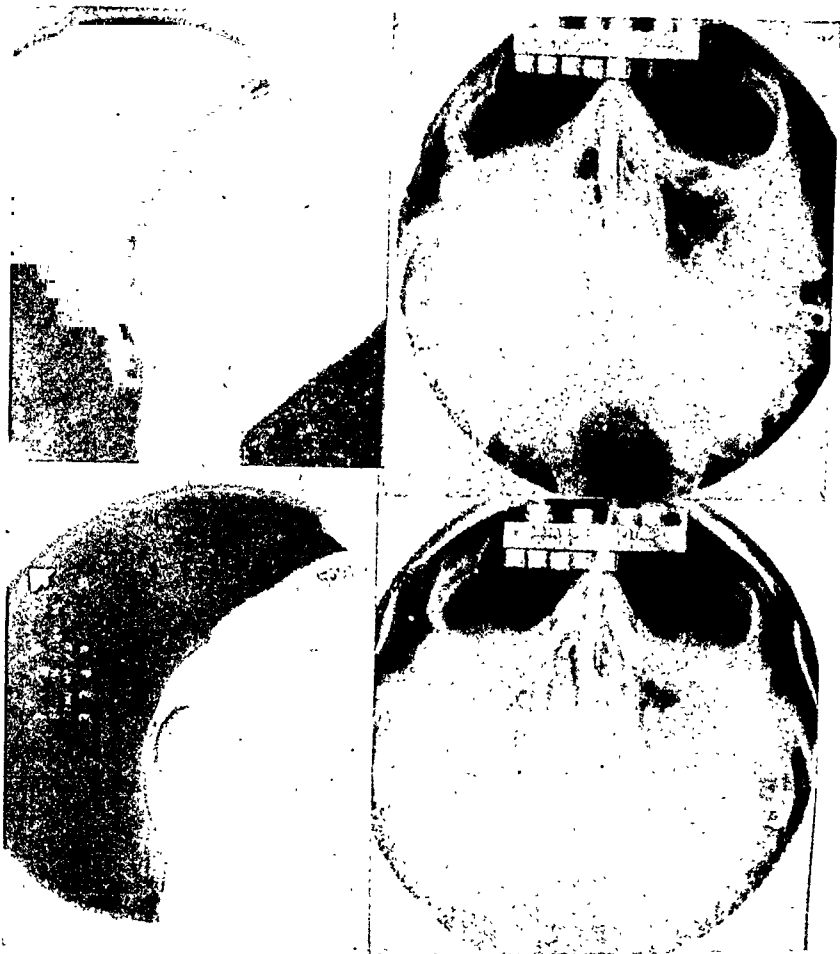


FIG. 6. CASE III. *Upper left:* Marked depression of right zygomatic arch with complete fractures at zygomaticotemporal suture line and through zygomatic process. *Upper right:* Note fractures at zygomaticofrontal and zygomaticotemporal suture lines, as well as through zygomatic process with depression. Orbital floor is markedly depressed and antrum is cloudy; diplopia is present. *Lower left:* Complete reduction of zygomatic arch. *Lower right:* Note complete reduction of arch but practically no change in position of orbital floor. Diplopia disappeared prior to reduction; antrum is clearing.

duction. Wiring may then be necessary for retention.

4. In the method of Matas, a silver wire is passed around the zygomatic arch by means of a curved cutting edge needle. Traction is applied and maintained through the wire, which is attached to a splint placed over the arch.

5. Ivy and Curtis insert a one-inch, ordinary screw-eye into a small drill hole

elastic band traction is applied to the depressed zygoma through the screw-eye.

6. A steel sound or other sturdy blunt instrument is passed through a small incision in the buccal fold and under the zygomatic arch. Leverage produces reduction.

7. Where the orbital floor and border are depressed, the steel sound can be passed through a small incision into the buccal fornix over the canine fossa and into the

antrum for reduction. External palpation along the orbital border indicates the degree of reduction.

buccal or nasal cavity has been reported to be advantageous since it permits removal of blood clot from the antrum at the time of



FIG. 7. CASE IV. *Upper left:* Marked depression of zygomatic arch, right, with complete fractures at zygomaticotemporal suture lines and through zygomatic process. *Upper right:* Note marked depression of arch with fractures at zygomaticofrontal and zygomaticotemporal suture lines as well as through the zygomatic process. The orbital floor is intact. *Lower left:* Reduction of arch not quite complete. Cosmetically, the result was good. *Lower right:* Almost complete correction of arch noted in this view.

8. Baxter employs an intrabuccal approach but avoids the antrum. The depressed fracture is reduced by means of an elevator at the fracture site. Reduction is maintained by a metal splint which is wired to the teeth and which supports the depressed zygoma until union occurs.

The last three methods traverse the buccal cavity in order to obtain reduction. The transantral approach, either from the

operation. There is no necessity for entering the antrum to remove the blood clot, since serial postoperative roentgenograms show that it is absorbed and disappears spontaneously. In patients treated by the transantral route, the antrum is irrigated regularly for several weeks postoperatively. The danger of antral irrigations in these cases cannot be overemphasized, and cases of maxillary sinusitis have been reported.

There is even a far greater danger of irrigating pathogenic organisms from the antrum through the fracture site into the orbit, causing orbital infection. Orbital cellulitis and even meningitis may result. The danger of serious infection by this approach has been previously emphasized and should, therefore, be avoided if possible. Operative procedures conducted through a clean field are safer and less likely to be followed by infection. The following method fulfills this requirement and has met with success generally.

9. The method of Gillies, Kilner and Stone is simple yet effective in cases of depressed fracture of the arch alone or combined with depression of the orbital floor. It is the method employed in all five of the patients treated in this series. The reduction should be performed as soon as possible unless there is contraindication due to the general condition of the patient. Generally, the earlier the reduction, the easier it is. However, one case reduced the same day of injury required considerable leverage force for reduction, due to impaction and marked depression. Loud crepitus could be felt and heard during reduction. Conversely, one fracture was reduced thirteen days after injury without difficulty and a second twelve days after injury with ease. The reduction is carried out through a clean field, and is therefore preferable to the procedures carried out through the buccal cavity. It is also preferable to the procedures requiring incisions directly over the zygoma, since the latter convert a simple into a compound fracture, with the compounding directly over the fracture site. With the Gillies method, therefore, there is much less likelihood of postoperative infection.

#### TECHNIC

The temporal region is shaved and prepared. A longitudinal incision  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long is made in the temporal region within the hairline. The longitudinal incision is preferred to a transverse incision, since there is less likelihood of injury to the

superficial temporal artery and auriculotemporal nerve. It is important that the incision be extended deeply through the temporal fascia, exposing fibers of the temporal muscle. A steel sound, Kelley clamp, or narrow periosteal elevator is then passed downward and forward superficial to the temporalis muscle and deep to the fascia into the temporal fossa beneath the depressed zygoma. The temporal fascia which covers the muscle attaches to the superior border of the zygoma and zygomatic process of the temporal bone. If the sound is not inserted beneath the fascia, but remains superficial to it in its passage downward and forward, it will not reach the temporal fossa behind the depressed bone. In its proper position, the steel sound is now employed as a lever to elevate the zygoma with the skull as a fulcrum. A folded gauze pad is placed over the skin beneath the sound to avoid untoward local pressure. The amount of force necessary to elevate the depressed bone varies with the amount of depression and impaction. Considerable strength is often required. At times the skull alone is inadequate as a fulcrum. A second sound placed over the padded region at right angles and beneath the inserted sound, may be necessary to act as a fulcrum in order to obtain sufficient levering force for reduction. External palpation along the zygoma and orbital border gives clinical evidence of the completeness of reduction. The sound is now withdrawn and the skin closed with one or two sutures. A collodion cotton dressing is applied.

As in any other type of fracture, maintenance of reduction is all important. If there is a tendency for the deformity to recur immediately after elevation of the depressed bone, either open reduction and wiring of the fragments will be necessary, or the traction methods of Matas or Ivy and Curtis can be employed. Traction of from four to seven days is generally sufficient to fix the fragments in place. None of the patients in my series required this. However, even when the elevated bone

retains its reduced position, one must guard against subsequent postoperative pressure producing a redisplacement of the fractured fragments. Because of fear that the patient may cause local pressure over the cheek bone during his sleep, a protective appliance is deemed necessary. A plaster-of-Paris headgear is applied, incorporating a wire ladder splint in such fashion as to have it extend from the temporal region on one side down over the same side of the face, under the chin and up over the opposite side of the face to be incorporated into the plaster at the opposite temporal region. The wire extends far enough under the chin so as not to interfere with motion of the mandible.

#### CASE REPORTS

**CASE I.** This patient was admitted to the hospital on October 21, 1943, with a history of having been struck on the face on October 9, 1943.

He presented an asymmetry of the face with depression of the left zygoma as well as the zygomatic arch. Local tenderness was present as well as ecchymosis. The left upper eyelid was swollen and discolored, but vision was normal. X-rays revealed a fracture of the zygoma at the zygomaticofrontal suture as well as the zygomaticotemporal suture line. The zygoma as well as the zygomatic arch were depressed with moderate depression of the orbital floor. The latter indicates a fracture of the zygomaticosphenoidal suture line also. Mild clouding of the antrum indicated some hemorrhage.

Open reduction was performed on October 22, 1943, under sodium pentothal intravenous anesthesia by the Gillies method. Excellent reduction of the depressed zygomatic arch was obtained and practically complete reduction of the depressed orbital floor. The  $\frac{1}{2}$  inch incision healed by primary union and the normal contour of the face was restored. Check-up x-ray revealed the clouding of the antrum to have disappeared. On November 17, 1943, the patient had no complaints and he was referred to the rehabilitation section for return to regular duty.

**CASE II.** This patient was admitted to the hospital on June 19, 1943, with a history of having been thrown into a tree by another

soldier while running to the mess hall. He struck the tree with the right side of his face. The injury occurred on the date of admission.

Examination revealed marked depression of the right cheek in the region of the zygomatic process of the temporal bone primarily, but extending forward toward the zygoma. Marked tenderness was present. There was some dried blood in the right nasal cavity, but there was no evident deformity of the nose. Mild local tenderness was present and vision was normal. Roentgenograms revealed a fracture of the zygoma at the zygomaticofrontal and zygomaticotemporal suture lines. There was also an incomplete fracture of the zygomatic process of the temporal bone. Mild depression of the orbital floor indicated a disruption of the zygomaticosphenoidal suture line. There was definite clouding of the antrum indicative of hemorrhage.

The patient was removed to the operating room immediately where open reduction was performed under local novocaine anesthesia by the Gillies method. A considerable amount of force was required, and during reduction bone grating could be felt and heard. The patient developed a moderate amount of postoperative swelling and ecchymosis, but these gradually disappeared. The  $\frac{3}{4}$  inch incision healed by primary union and asymmetry of the face was completely corrected. Roentgenograms revealed excellent reduction of the zygomatic arch and practically complete correction of the orbital floor. On July 31, 1943, the patient had no complaints and the fracture was clinically united. He was returned to regular duty following a convalescent furlough.

**CASE III.** This patient was admitted to the hospital on July 22, 1943, with a history of having been struck on the right side of the face with an unknown object by another soldier.

Examination revealed the patient to be markedly dazed. There was moderate swelling of the cheek but palpation revealed the depression of the zygoma as well as the orbital floor. Vision was interfered with and the patient had diplopia. In view of the concussion, reduction was delayed and the patient was put at rest. Roentgenograms taken four days later revealed the fracture of the zygoma at the zygomaticofrontal and zygomaticotemporal suture lines. It also revealed a fracture through the zygomatic process of the temporal bone with marked depression of the arch. The orbital floor was

also markedly depressed and clouding of the antrum indicated hemorrhage therein.

The patient's general condition improved and despite the considerable depression of the orbital floor, the diplopia had disappeared by July 26, 1943.

Accordingly on July 27th an open reduction was performed under local novocaine anesthesia. The sharp points of a sturdy skin clamp were forced through the skin and soft tissue over the medial portion of the right zygoma, just lateral to the zygomaticomaxillary junction. The zygoma was grasped with this instrument, one prong fixing the bone beneath the orbital border and the other prong under the inferior border of the zygoma. With firm steady traction forward, the zygoma was felt to give and be lifted from its depressed position. The jagged edge previously felt at the orbital border had disappeared. However, the depression of the lateral portion of the zygoma and zygomatic process of the temporal bone still remained. This could not be further corrected by the towel clamp, since its prongs would bend and slip when traction was applied. The Gillies method was therefore employed for further correction. It was noted that there was a tendency for the elevated arch to fall back again each time leverage was removed, but finally the clinically reduced fragments retained their corrected position. Immediate check-up x-ray revealed excellent reduction of the zygomatic arch. A plaster-of-Paris headgear with ladder wire splint was applied. The patient removed this the following night, however, because of moderate postoperative swelling. It was subsequently reapplied. Check-up roentgenograms taken September 3, 1943, still revealed the excellent reduction of the zygomatic arch, but little if any correction of the depressed orbital floor. Despite this, however, the diplopia did not reappear. The clouding of the antrum had faded almost completely. The patient was returned to regular duty.

CASE IV. This patient was admitted to the hospital on August 16, 1943, with a history of having been struck on the face during a friendly scuffle the same day.

Examination revealed the usual findings characteristic of a depression of the zygomatic arch. There was no diplopia. The roentgenograms revealed a marked depression of the arch without depression of the orbital floor on the right side. There was a fracture of the

zygoma at the zygomaticofrontal and zygomaticotemporal suture lines with marked depression at the latter site. In addition there was also a fracture of the zygomatic process of the temporal bone.

Open reduction was performed on August 18th under sodium pentothal intravenous anesthesia by the Gillies method. Palpation indicated a complete reduction, although check-up x-rays indicated that the reduction was not quite complete. Cosmetically, however, the asymmetry of the face was corrected and the patient had no residual symptoms. The  $\frac{3}{4}$  inch incision healed by primary union. He returned to regular duty on October 26, 1943.

CASE V. This patient was admitted to the hospital on October 3, 1943, with a history of having been struck in the face the same day during an altercation with another soldier.

Upon examination he presented the characteristic clinical evidence of a depressed fracture of the left zygoma. His face was considerably swollen, however, and there were several small lacerations over both sides of the face, lips, and eyes. There was no diplopia, however.

In view of the marked local reaction, it was deemed advisable to delay reduction until the swelling had subsided and the wound appeared in better condition. The wounds were cleansed and dressed. On October 15, 1943, open reduction was performed by the Gillies method and complete correction was obtained without difficulty, despite the delay of twelve days. The patient made an uneventful recovery and returned to regular duty on December 18, 1943.

#### COMMENT

Although fractures of the zygoma are rarely encountered in civilian life, a series of five patients was treated at a Station Hospital in the short span of eight months. The etiological factor is a direct blow or impact. The body of the malar bone is rarely involved, but the fracture usually takes place at the suture lines which join the zygoma with the frontal, sphenoidal, maxillary and temporal bones. In addition, the zygomatic process of the temporal bone may also be fractured and depressed. Diplopia may be a complication but it does not appear to be directly related to the

depression of the orbital floor. At least all cases having depression of the orbital floor do not have diplopia. Also in many cases with diplopia, this complicating symptom disappears without the orbital floor having been reduced either in part or whole. It appears that the diplopia may be due to incoordination of the extra-ocular muscles as a result of hemorrhage and edema. Given adequate time for the edema to subside and the hemorrhage to absorb, the diplopia may clear up in most cases with mild or moderate depression of the orbital floor. The necessity of surgical approaches through the buccal cavity and antrum to correct this depression can therefore be avoided, since its presence in mild or moderate degree is innocuous. In addition, the extra-oral approach of Gillies gives excellent reduc-

tion of the zygomatic arch and adequate reduction of the orbital floor in most instances. Five cases have been reported with good reduction in all instances by this method. A plaster headgear with ladder wire splint incorporated has been described for postoperative protection of the reduced zygomatic arch.

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# ACUTE SUPPURATIVE AND GANGRENOUS CHOLECYSTITIS

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THE published literature on gallbladder disease is voluminous. Much has been written on the acute condition of the gallbladder and experimental work has been done suggesting that the underlying pathology is usually a mechanical obstruction to the cystic duct with edema and ischemia of the vesicle wall followed by a secondary infection.<sup>25</sup>

Opinion has clashed sharply over the policy of immediate or delayed surgery in cases of acute cholecystitis and the relative surgical risks involved, the former policy committing the surgeon to the routine necessity of operating in a septic edematous field while the latter opinion subjects the patient to the dangers of a lesion that may be progressive.<sup>1,3,6,8,11,12,26</sup>

It has been shown that acute cholecystitis can resolve itself into two types of end results, namely, a spontaneous resolution without surgical interference, and a progression with termination in gangrene or empyema. It was, therefore, deemed wise to study a group of patients showing such advanced disease as empyema and/or gangrene, with or without perforation of the gallbladder wall.

## MATERIAL

The material used was from the files of the Jewish Hospital, a general hospital with an adult surgical and medical capacity of 224 beds. The records of this institution for a fifteen-year interval (1929 to 1944) were searched and the charts of all patients carefully reviewed that seemed to come within the scope of this study. Only those charts were considered in which the diagnosis was definitely established either by operation or autopsy.

The pathological report was considered the correct final diagnosis. This, however, was not always available as in those patients in whom a cholecystostomy was performed no tissue was removed. Here the diagnosis accepted was the one made at the operating table. Because of the diversity of nomenclature employed by different examiners, it was decided to include as one group all patients, whether purulent or gangrenous, under the heading of Advanced Gallbladder Disease. Those patients showing either an acute perforation of the gallbladder or an old chronic one with localized abscess formation were classified as Advanced Gallbladder Disease—Perforated.

## ADVANCED GALLBLADDER DISEASE— HISTORY AND SYMPTOMS

There were eighty-two such cases of whom thirty (37 per cent) were males and fifty-two (63 per cent) females. It is interesting to note that there were approximately one and one-half times as many women as men in this series, the same incidence with which cholelithiasis was found to be present in this hospital in a study of routine necropsies.<sup>4</sup>

Patients ranged in age from twenty-nine to seventy-two years with an average age of 53.3 years for the men and 55.9 years for the women.

Fallis and McClure<sup>9</sup> reviewed 320 cases of acute cholecystitis and found that the disease occurred twice as often in females as in males. Judd and Phillips<sup>16</sup> reported on 508 consecutive patients with acute cholecystitis who came to operation, 40 per cent of whom were men.

In a survey of several hundred gallbladder operations, Russo<sup>19</sup> found that

females outnumbered the males by 6 to 1 in the chronic cases but only 2 to 1 in the acute cases.

This is at variance with the report of Glenn and Moore<sup>10</sup> who discussed eighty-four cases of gangrene of the gallbladder, forty-four of whom were women and forty men, although the ratio of men to women in 1,500 chronic cases was only 1 to 4.

TABLE I  
ADVANCED GALLBLADDER DISEASE—INCIDENCE  
(Acute Suppurative and/or Gangrenous Cholecystitis)

| Age   | Males     |          | Females   |          | All       |          |
|-------|-----------|----------|-----------|----------|-----------|----------|
|       | No. Cases | Per Cent | No. Cases | Per Cent | No. Cases | Per Cent |
| 20-30 | 1         | 3.3      | 1         | 1.9      | 2         | 2.4      |
| 31-40 | 5         | 16.7     | 6         | 11.5     | 11        | 13.4     |
| 41-50 | 7         | 23.3     | 7         | 13.5     | 14        | 17.1     |
| 51-60 | 5         | 16.7     | 19        | 36.6     | 24        | 29.3     |
| 61-70 | 11        | 36.7     | 15        | 28.8     | 26        | 31.7     |
| 71-80 | 1         | 3.3      | 3         | 5.8      | 4         | 4.9      |
| 81-90 | 0         | 0.0      | 1         | 1.9      | 1         | 1.2      |
| Total | 30        | 100.0    | 52        | 100.0    | 82        | 100.0    |

Taylor<sup>24</sup> studied 129 cases of acute cholecystitis and 20 per cent of the total were men; sixty were acutely suppurative with an average age of 43.7 years. He also discussed twenty-nine cases of acute gangrenous cholecystitis with an average age of 50.8 years for the entire group, 38 per cent of them males.

Steinke<sup>22</sup> reported on 200 cases of acute cholecystitis 27 per cent of whom were men. There were thirty cases of advanced gallbladder disease in his series and males constituted 43 per cent of this segment. The average age of the advanced group was 47.3 years.

In our group presented for discussion, a history of symptoms referable to the biliary tract and experienced prior to the present attack was given by fifty-four patients (66 per cent) while only six patients definitely denied such symptoms. The history in the remaining cases was rather vague.

Many of the patients gave a history of gallbladder disease of moderate severity extending over a great many years, in some instances for as many as twenty years. It is interesting to realize that many people knowingly preferred to suffer for so long rather than submit to surgery and the reasonable assurance of lasting relief.

Fallis and McClure<sup>9</sup> found that only 12.5 per cent of their 320 patients with acute cholecystitis had no previous warning of gallbladder disease. Many of their patients had had one or more previous attacks over a period of many years. Of their entire group, 86.8 per cent had had prior medical management for gallbladder disease. Judd and Phillips<sup>16</sup> found that although 248 (49 per cent) of their 508 operative cases of acute cholecystitis were having their first attack, only five patients gave no history of prior symptoms referable to gallbladder disease.

TABLE II  
ADVANCED GALLBLADDER DISEASE  
(Acute Suppurative and/or Gangrenous Cholecystitis)  
Duration of Present Attack

| Days       | Males | Females | Total |
|------------|-------|---------|-------|
| 1          | 1     | 0       | 1     |
| 2          | 1     | 3       | 4     |
| 3          | 3     | 7       | 10    |
| 4          | 3     | 3       | 6     |
| 5          | 1     | 1       | 2     |
| 6          | 2     | 3       | 5     |
| 7          | 2     | 4       | 6     |
| 8-10       | 4     | 11      | 15    |
| 11-14      | 3     | 7       | 10    |
| 15-21      | 2     | 3       | 5     |
| over 21    | 2     | 10      | 12    |
| Indefinite | 6     | 0       | 6     |
|            | 30    | 52      | 82    |

The interval between the onset of the present attack of pain and its termination by either operation or an antecedent demise we found to average twelve days for the men and thirteen and one-half days for the women. Some of the operative delay was deliberate since it was the common practice in this hospital to operate on acute gallbladder patients only if

deemed necessary by the presence of a progressive lesion and, instead, to follow the conservative plan of waiting for subsidence of the acute symptoms whenever feasible.

The abdominal pain in our patients usually originated either (1) in the right upper quadrant, (2) in the epigastrium, or (3) as a generalized abdominal pain. Radiation of the pain was present in about 50 per cent of the patients and was usually referred to the back, right shoulder or across the upper abdomen; only a few patients gave a story of radiation to the left shoulder.

TABLE III  
ADVANCED GALL BLADDER DISEASE  
(Acute Suppurative and/or Gangrenous Cholecystitis)  
Localization of Abdominal Pain at Onset of Present Attack

|   | Males | Fe-<br>males | Total |       |
|---|-------|--------------|-------|-------|
|   |       |              | No.   | %     |
| Epigastrium.....                              | 6     | 4            | 10    | 12.2  |
| Right upper quadrant.....                     | 16    | 30           | 46    | 56.0  |
| Generalized.....                              | 3     | 10           | 13    | 15.9  |
| Epigastrium and right upper<br>quadrant.....  | 0     | 4            | 4     | 4.9   |
| Right lower quadrant.....                     | 0     | 3            | 3     | 3.7   |
| Right upper and right lower<br>quadrants..... | 0     | 1            | 1     | 1.2   |
| Indefinite.....                               | 5     | 0            | 5     | 6.1   |
|   | 30    | 52           | 82    | 100.0 |

In one series,<sup>24</sup> the pain of patients suffering with an acute suppurative or gangrenous gallbladder was found to be present in the right upper abdominal quadrant in all instances, a universal finding with which our records do not agree. The pain in that series<sup>24</sup> was referred in about 60 per cent of instances to the back, epigastrium or shoulder.

Abdominal distention was not often noted in our records. Marked tenderness was usually present and fairly well localized to the right upper quadrant. (Table iv.)

A history of chills and fever with the present attack prior to hospitalization was obtained in only nine instances (11.0 per cent). Such a history was obtained by Steinke<sup>22</sup> in 7 per cent of his group of cases with acute cholecystitis. Nausea, vomiting or both were present in most cases. Only five patients each, of our male and female groups, specifically denied experiencing either nausea or vomiting. There was no clinically consistent change in bowel habit. Many patients noted a marked constipation but a large number failed to mention any change while a few had diarrheal stools.

TABLE IV  
ADVANCED GALLBLADDER DISEASE  
(Acute Suppurative and/or Gangrenous Cholecystitis)

|                           | No. Cases | Per Cent |
|---------------------------|-----------|----------|
| Tenderness—exquisite..... | 44        | 53.6     |
| severe.....               | 13        | 15.9     |
| moderate.....             | 9         | 10.9     |
| slight.....               | 5         | 6.1      |
| none.....                 | 4         | 4.9      |
| indefinite.....           | 7         | 8.6      |
| Total.....                | 82        | 100.0    |

Taylor<sup>24</sup> found that 88 per cent of his series with advanced gallbladder disease had experienced either nausea or vomiting. Nausea was noted in 91 per cent and vomiting in 83 per cent of their patients of acute cholecystitis by Fallis and McClure.<sup>9</sup>

Jaundice was found clinically in 10 per cent of the patients during the present attack. There was a history of previous jaundice in only 6 per cent of all patients; many of these had no jaundice during the present attack. A twenty to twenty-five per cent incidence of clinical jaundice was found in Taylor's<sup>24</sup> patients and also in those of Fallis and McClure.<sup>9</sup>

*Signs.* On admission to the hospital, palpation of the gallbladder was attempted in almost all instances. An enlarged mass in the right upper quadrant was definitely palpated in thirty-eight patients (46.3 per cent), definitely not palpated in thirty-five cases (42.7 per cent). The findings in the

remaining nine were doubtful. Such a mass was found preoperatively in several published series in about 20 per cent of the patients.<sup>9,16</sup>

The preoperative temperature during hospitalization was usually of the sustained type rather than a septic one, with a peak temperature in some cases up to 103°F. while in others it barely exceeded a normal 98.6°F. Most patients, however, ran a moderate fever, the average peak temperature being 101°F. The pulse rate was for the most part increased in proportion to the temperature. An average maximum temperature of 100°F. preoperatively was noted by Taylor<sup>24</sup> in his comparable group.

The average blood pressure reading on admission to the hospital was 134/79 for the men and 144/80 for the women. The readings varied widely between patients as might be expected in any group whose average age was over fifty years.

TABLE V  
ADVANCED GALLBLADDER DISEASE  
(Acute Suppurative and/or Gangrenous Cholecystitis)  
White Cell Count on Admission to Hospital

| White Cells per cu. mm. | Males | Females | All Patients |          |
|-------------------------|-------|---------|--------------|----------|
|                         |       |         | No. Cases    | Per Cent |
| 6-10 M                  | 4     | 11      | 15           | 18.5     |
| 10-15 M                 | 12    | 14      | 26           | 32.1     |
| 15-20 M                 | 10    | 16      | 26           | 32.1     |
| 20-25 M                 | 0     | 6       | 6            | 7.4      |
| over 25 M               | 3     | 5       | 8            | 9.9      |
|                         | 29*   | 52      | 81*          | 100.0    |

\* Data lacking for one patient.

**Laboratory Findings.** A peripheral blood cell count was done on most patients shortly after admission with repeat counts thereafter. The average white cell count on admission was 15,660 cells per cu. mm. for males and 15,870 cells per cu. mm. for females. The average figures for neutrophils was 81.3 per cent and 80.2 per cent, respectively. In similar reported groups com-

binning both sexes, the average count was 17,122 cells per cu. mm.,<sup>22</sup> and 16,700 cells per cu. mm.<sup>24</sup> The neutrophil percentage was approximately 81 per cent.<sup>24</sup>

In a great many of our patients, the white cell count tended to fall prior to surgical interference. The average white cell count performed a day or so before operation was 14,060 cells per cu. mm. with 80.9 per cent neutrophils for the males and 13,950 cells per cu. mm. with 76.3 per cent neutrophils for the females. Since all of these patients had progressive and probably non-resolving lesions, it is obvious that the fall in blood count was not necessarily indicative of pathological improvement. This fall in count has already been noted.<sup>24</sup>

With the exception perhaps of some concentration due to dehydration, the red cell count was quite normal in most instances. The average count was 4,660,000 cells per cu. mm. with 87.4 per cent hemoglobin for the male group and 4,316,000 cells per cu. mm. with 81.4 per cent hemoglobin for the female group. (The hemoglobin standard used was 13.8 Gm. equals 100 per cent.)

In addition to thirteen patients with known diabetes mellitus, fifty-one patients in our series had fasting blood sugar determinations. Levels of less than 100 mg. per cent were obtained in twenty instances, 39 per cent of the non-diabetic group. Readings of 100 mg. per cent to 120 mg. per cent were obtained in nineteen patients, 37 per cent of the non-diabetic group. The remaining twelve non-diabetic patients showed blood sugar levels in excess of 120 mg. per cent, only four of them over 150 mg. per cent. The elevated blood sugar levels in these cases were probably caused by such factors as concomitant coronary occlusion, intravenous glucose therapy shortly before the test, and perhaps one or two cases of unrecognized diabetes mellitus. Certainly there was nothing to suggest any tendency to produce an elevated fasting blood sugar level such as is known to occur in acute coronary occlusion,

A blood urea nitrogen determination was made in sixty-three cases and this likewise was within normal limits in most patients, 20 mg. per cent or less in forty-nine cases (78 per cent of the tested patients). Elevations not exceeding 35 mg. per cent, (a level easily reached with dehydration) were shown by twelve patients. In the remaining two cases, instances one each of acute coronary occlusion and bronchopneumonia, the figure was in excess of 35 mg. per cent.

#### ADVANCED GALLBLADDER DISEASE— PERFORATED

An attempt to correlate severity of disease with clinical and laboratory findings was considered advisable, and for this purpose, the records of perforated gallbladders were studied separately.

There were twenty-one such cases (25 per cent of the entire group), nine males and twelve females. These were not necessarily all of recent origin, some of them being well encapsulated by adhesions and omentum while only three were associated with widespread peritonitis. Rupture into the duodenum occurred in one instance; there was no penetration of any other abdominal viscus.

The average age was 61.8 years for the men and 57.1 years for the women, representing an older segment of the original group.

In Taylor's series,<sup>24</sup> rupture of the gallbladder was found in fifteen patients (11.6 per cent of all his cases of acute cholecystitis). The process was diffuse in four instances. Judd and Phillips<sup>15</sup> found sixty-one patients with a perforated gallbladder in their group of 508 cases of acute cholecystitis, of whom three showed generalized peritonitis; forty-three were females and eighteen males. The majority of the perforated patients were fifty years old or over. Perforation into an adjacent viscus occurred in seven patients.

Of the eighty-four cases of gangrene of the gallbladder described by Glenn and Moore,<sup>10</sup> twenty-two showed perforation

with a localized abscess while three other patients had a free perforation with generalized peritonitis. The average age for the perforated group was about fifty years while that for the non-perforated group was only forty-four years.

A group of twenty-five cases with gallbladder perforation was reported by Cowley and Harkins<sup>5</sup> of whom sixteen (64 per cent) were women and the other nine (36 per cent) men. More than 60 per cent of the patients were over fifty years. Of the forty-six patients also with perforation of the gallbladder described by Sanders,<sup>20</sup> twenty-two were women with an average age of fifty years and twenty-four men with an average age of fifty-five years. Stone and Douglass<sup>23</sup> presented seventeen such patients whose average age was fifty-two years, ten of them women. The twenty cases of Schaeffer<sup>21</sup> had an average age of fifty-nine years. Atlee and Atlee<sup>1</sup> reported sixteen patients with gallbladder perforation who had an average age of fifty-seven years and whose numbers were divided equally between the sexes. A free perforation was found in four instances and one patient had developed a duodenal fistula.

Edwards, Gerwig and Guyton<sup>7</sup> reported on 194 cases of acute cholecystitis of whom twenty-one were instances of perforation (10.8 per cent). Approximately this incidence has been reported by many other observers.<sup>2</sup> Review of the literature by Cowley and Harkins<sup>5</sup> showed 13 per cent to be perforated.

Our patients with perforation of the gallbladder gave a history of antecedent gallbladder disease varying from a short interval in some patients to a very long one in others, occasionally fifteen to twenty years. In only three cases did the patient deny any prior biliary dysfunction. All of the sixty-one perforated patients reported by Judd and Phillips<sup>15</sup> had had earlier symptoms referable to the biliary tract and forty-eight of them had had previous acute symptomatology. Prior symptoms were acknowledged by thirty-seven of the forty-six patients presented

by Sanders.<sup>20</sup> The incidence was 90 per cent in the group of Cowley and Harkins<sup>5</sup> while Atlee and Atlee's<sup>1</sup> patients all had attacks previously.

The average duration of the acute recent attack until its termination by either operation or demise was eleven days for our female patients and eight days for the male, a shorter interval than for the general group. Apparently the acuteness of the average perforated case was noted and an earlier interference practiced. In eight instances surgery was performed within seven days of the acute onset, five of these within three days. This checks closely with the average figure of 9.6 days noted by Taylor.<sup>24</sup>

A mass in the region of the gallbladder was definitely palpated in about one-third of the perforated patients which was also the finding of Judd and Phillips<sup>15</sup> and Sanders.<sup>20</sup> Cowley and Harkins<sup>5</sup> noted such a mass in 24 per cent of their cases.

The pain was as diversified in onset as in the general group. However, it seemed to be more widespread, fully 50 per cent of patients having pain across the entire upper abdomen from the very onset. The pain and tenderness found was more severe and more often present than in the general group, fully two-thirds of the patients showing extreme tenderness and abdominal rigidity. It is interesting to note that among the remaining one-third of the patients were some in whom the perforation was apparently of long duration and in whom a state of localized chronic abscess formation had occurred. These patients showed very little tenderness or rigidity. Virtually all of the patients with an acute perforation experienced both nausea and vomiting.

In the perforated group, the average count on admission was 16,600 white blood cells per cu. mm. with 82 per cent neutrophils. Three cases had counts in excess of 26,000 cells per cu. mm. Of sixty-one patients with perforated gallbladders reported by Judd and Phillips,<sup>15</sup> twenty-five showed a white cell count in excess of

10,000 cells per cu. mm. and in seven of these it was over 20,000 cells per cu. mm. In a similar series of twenty-one patients, Edwards, Gerwig and Guyton<sup>7</sup> found the count to be from 18,000 to 20,000 white cells per cu. mm. The patients of Stone and Douglass<sup>23</sup> had an average count of 14,000 white cells per cu. mm.

**Surgery.** Surgery of the gallbladder was performed in seventy-three cases, 89 per cent of our entire series of patients with advanced gallbladder disease. The type of operation performed varied from a simple incision and drainage of the gallbladder to complete excision, the more serious cases receiving the most simplified surgery. Complete cholecystectomy was done in approximately one-half of the operative cases both of men and women.

TABLE VI  
TYPES OF ANESTHESIA USED

|  | Spinal | Ether | Local | N <sub>2</sub> O + O <sub>2</sub> | None (no op.) | Total |
|--|--------|-------|-------|-----------------------------------|---------------|-------|
| Ac. sup. and/or gang. cholecystitis..... | 59     | 2     | 9     | 3                                 | 9             | 82    |
| No. died.....                            | 7      | 1     | 1     | 2                                 | 9             | 20    |
| Per cent.....                            | 11.9   | 50.0  | 11.1  | 66.7                              | 100.0         |       |
| Rupt. cholecystitis only.                | 14     | 0     | 3     | 0                                 | 4             | 21    |
| No. died....                             | 3      | 0     | 0     | 0                                 | 4             | 7     |

In the perforated group, complete cholecystectomy was performed in only three instances while fourteen other patients were treated with simple incision and drainage.

The anesthesia of popular choice was spinal, which was used in fifty-nine (81 per cent) of the seventy-three operative cases. Supplementary anesthesia was necessary in seven instances, the methods used being inhalation nitrous oxide-oxygen, ether or intravenous pentothal sodium. Nine patients had their operation under local and the remaining five cases were done under either ether or nitrous oxide-oxygen supplemented with ether.

In the perforated group, fourteen patients had spinal anesthesia and the remaining three patients received local.

**Cholelithiasis.** Most of the gallbladders were examined carefully for stones. This examination was of necessity not very carefully performed in some operative cases in which a cholecystostomy was necessary. Stones were definitely found in sixty-five patients, 79 per cent of the eighty-two in our series. In eleven of the remaining patients, minimal exploratory surgery made it impossible to ascertain the presence or absence of stones; in six instances, 7.3 per cent of the entire series, (some at postmortem), ample opportunity for examination was available and a careful search failed to reveal any evidence of stones.

Gallstones were found in two-thirds of the patients in the perforated group. In only one patient was no such finding present even though a careful search was possible and was made.

TABLE VII  
ADVANCED GALLBLADDER DISEASE  
(Acute Suppurative and/or Gangrenous Cholecystitis)

|                    | Males     |          | Females   |          |
|--------------------|-----------|----------|-----------|----------|
|                    | No. Cases | Per Cent | No. Cases | Per Cent |
| Gallbladder stones |           |          |           |          |
| Present.....       | 24        | 80.0     | 41        | 78.8     |
| Not present.....   | 3         | 10.0     | 3         | 5.8      |
| Doubtful.....      | 3         | 10.0     | 8         | 15.4     |
| Total.....         | 30        | 100.0    | 52        | 100.0    |

Steinke<sup>22</sup> found stones present in 77 per cent of his thirty patients with advanced gallbladder disease. Taylor<sup>24</sup> noted stones in 94 per cent of all his cases of acute cholecystitis. He found no difference between the frequency with which stones were present and the degree of the pathological condition. A similar incidence of stones was noted by Schaeffer.<sup>21</sup> In the eighty-four cases with gangrene of the gallbladder described by Glenn and Moore,<sup>10</sup> five of the forty men had no stones but in all of the forty-four women, stones were

found. Judd and Phillips<sup>15</sup> found gallstones in 92 per cent of their perforated patients. Stones were present in forty-two of the forty-six cases reported by Sanders<sup>20</sup> and in 92 per cent of those described by Cowley and Harkins.<sup>5</sup>

**Mortality.** In the complete group of eighty-two cases, twenty died during their hospital stay (almost 25 per cent). Of the seventy-three operative patients, eleven died postoperatively for a gross surgical mortality of 15.1 per cent.

The records of all the deceased patients were checked and the cause of death determined as accurately as possible. Patients were then classified into the following etiological groups: (I) Death as a direct result of biliary tract disease; (II) death as a result of disease aggravated by the biliary disease, and (III) death as the result of disease apparently unrelated to biliary disease and uninfluenced by it.

There were twelve patients in the first category, four patients in the second and four in the third. In the last named group, empyema of the gallbladder was an incidental finding at postmortem.

Despite the lessened trauma attending gallbladder incision in contrast to excision, the mortality was much greater (over twice as much) in the group of patients treated by cholecystostomy. It must be remembered, however, that the people cared for in this manner were, for the most part, the poorest risks.

The average age of the group that died was 60.5 years, an average definitely higher than that for the non-fatal cases. This is not surprising considering the relative frequency with which the severer forms of cholecystitis are found in older people.

The average interval between the onset of the most recent acute attack and its termination either by operation or the prior demise of the patient was 10.5 days. This is greater than the comparative figure for the non-fatal group, partly due to the poor condition of some of the patients with severe concomitant disease forbidding early

interference. The white cell count averaged 16,300 cells per cu. mm.; 81.8 per cent of the cells were polymorphonuclear cells.

diabetic patients in the present series. The significance of this will be discussed later.

TABLE VIII  
OPERATIVE MORTALITY

|                      | Ac. Sup. and/or Gang. Cholecystitis |          |        |          | Rupt. Cholecystitis Only |          |        |          |
|----------------------|-------------------------------------|----------|--------|----------|--------------------------|----------|--------|----------|
|                      | No. Cases                           | Per Cent | Deaths | Per Cent | No. Cases                | Per Cent | Deaths | Per Cent |
| Cholecystostomy..... | 40                                  | 54.8     | 8      | 20.0     | 14                       | 82.3     | 3      | 21.4     |
| Cholecystectomy..... | 33                                  | 45.2     | 3      | 9.1      | 3                        | 17.7     | 0      | 0.0      |
| Total oper. pts..... | 73                                  | 100.0    | 11     | 15.1     | 17                       | 100.0    | 3      | 17.7     |
| No operation.....    | 9                                   |          | 9      |          | 4                        |          | 4      |          |
| Total.....           | 82                                  |          | 20     |          | 21                       |          | 7      |          |

Judd and Phillips<sup>15</sup> had six deaths in their series of sixty-one patients operated upon for acute perforated cholecystitis; five deaths followed cholecystectomy performed on forty-eight patients and one death followed cholecystostomy on thirteen patients. In the twenty-one perforated cases described by Edwards et al.,<sup>7</sup> three were moribund on admission and died without the benefit of surgery. Of the other eighteen patients, three died postoperatively, making an overall mortality of 29 per cent and a gross surgical mortality of 17 per cent. The best results were those of Eliason and Stevens<sup>8</sup> who performed a cholecystostomy of seventeen patients with gallbladder perforation without any deaths.

**Diabetes Mellitus.** There were thirteen diabetic patients in our entire series. Several years ago, a check of 1,500 consecutive medical deaths that occurred in this hospital showed that diabetic patients constituted 7.7 per cent of the total.<sup>27</sup> In another study conducted here, it was also found that diabetic individuals had over twice the tendency to develop cholelithiasis as had other patients, making diabetics about 16 per cent of all the cases showing gallstones.<sup>4</sup> This is almost the same as the figure of 15.9 per cent, the percentage of

Our diabetic series of gallbladder patients consisted of five males and eight females with an average age of 61.4 years. The relative sex incidence was, therefore, the same as for all other cases of advanced gallbladder disease though the average age was increased. About half of the patients were operated upon within a week of onset of their most recent attack. An enlarged gallbladder was palpated preoperatively in nine cases, not palpated in the remaining four patients. The average white cell count on admission was 15,200 per cu. mm. with 81 per cent neutrophils, averages almost identical with those for the general non-diabetic group. There were three perforated cases among the thirteen diabetic patients making an incidence of 23 per cent, another point of similarity between the two series, diabetic and non-diabetic.

Of the thirteen patients in our diabetic group, eleven (85 per cent) came to operation. There were two cholecystostomies performed under local anesthesia, six cholecystostomies and three cholecystectomies under spinal anesthesia. Gallstones were found in ten instances, 77 per cent of the diabetic patients.

The mortality for patients with diabetes was very high, seven (54 per cent) dead in



a group of thirteen patients. Considered from another angle, the seven diabetic deaths constituted 35 per cent of the total mortality though the diabetic patients were only 15.9 per cent of the entire series. Furthermore the diabetic deaths were all in Class I or II, deaths due directly or

that there were no deaths. They described seventeen cholecystectomies and two cholecystostomies in cases of simple cholelithiasis, and four cholecystectomies and one cholecystostomy in cases of suppurative or gangrenous disease of the gall bladder, all in diabetics.

TABLE IX  
MALE DEATHS

| Pts. Initials | Age | W.B.C. on Admission |         | Duration of Recent Attack (Days) | Peak Preop. Temp. (Fahren.) | Primary Final Diagnosis                             | Contributory Diagnosis                        | GB Stones Present | GB Ruptured | Diabetic | Operation | Anesthesia       | Type of Operation | Class (See Text) | Total Duration GB Symptoms |
|---------------|-----|---------------------|---------|----------------------------------|-----------------------------|---|---|-------------------|-------------|----------|-----------|------------------|-------------------|------------------|----------------------------|
|               |     | Cells/cu. mm.       | % Neut. |                                  |                             |   |   |                   |             |          |           |                  |                   |                  |                            |
| N.R.          | 46  | 12,400              | 76      | 8                                | 103                         | 1. Diffuse Peritonitis<br>2. Ac. Empyema GB         | .....   | no                | yes         | no       | no        | .....            | .....             | 1                | 5 years                    |
| F.C.          | 69  | .....               | .....   | .....                            | .....                       | Ac. Ant. Coronary Occ.<br>Cancer of Sigmoid         | Chr. Empyema GB                               | no                | yes         | no       | no        | .....            | .....             | 3                | indefinite                 |
| P.S.          | 70  | 12,000              | 70      | .....                            | .....                       | 1. Ac. Empyema GB                                   | Chr. Empyema GB                               | yes               | yes         | no       | no        | .....            | .....             | 3                | .....                      |
| A.S.          | 68  | 25,400              | 85      | 7                                | 102                         | 2. Ac. Sup. Pancreatitis<br>1. Bilat. Bronchopneum. | .....   | yes               | no          | yes      | no        | .....            | .....             | 1                | 3 years                    |
| W.S.          | 45  | 25,000              | 91      | 4                                | 103.6                       | 2. Ac. Empyema Thoracis                             | Ac. Empyema GB                                | yes               | no          | yes      | no        | .....            | .....             | 2                | .....                      |
| J.G.          | 68  | 8,500               | 56      | .....                            | 98.6                        | 1. Bilat. Bronchopneum.<br>2. Ac. Empyema Thoracis  | 1. Chr. Empyema GB<br>2. Ununited Frac. Femur | yes               | no          | no       | no        | .....            | .....             | 3                | .....                      |
| I.S.          | 43  | 9,700               | 72      | .....                            | 98.0                        | Ac. Empyema GB                                      | Ac Toxic Hepatitis                            | yes               | no          | no       | yes       | N <sub>2</sub> O | -ectomy           | 1                | 2 years                    |
| P.M.          | 51  | 20,500              | 82      | 9                                | 100.4                       | Bilat. Bronchopneum.                                | Ac Empyema GB                                 | yes               | no          | yes      | yes       | N <sub>2</sub> O | -ectomy           | 2                | indefinite                 |
| L.F.          | 66  | 14,000              | 88      | 9                                | 103                         | Bilat. Bronchopneum.                                | Ac Empyema GB                                 | ?                 | no          | yes      | yes       | spinal           | -ostomy           | 2                | indefinite                 |
| M.S.          | 64  | 20,000              | 91      | 11                               | .....                       | 1. Ac. Empyema GB<br>2. Sec. Liver Abscesses        | .....   | yes               | yes         | yes      | yes       | spinal           | -ostomy           | 1                | 7 wks.                     |
| C.B.          | 61  | 8,500               | 78      | 2                                | 101                         | 1. Diffuse Peritonitis<br>2. Ac. Empyema GB         | .....   | yes               | yes         | no       | yes       | spinal           | -ostomy           | 1                | 20 years                   |

indirectly to the biliary condition. If the four cases of Class III non-diabetic deaths are omitted from consideration, then diabetic fatalities totaled 44 per cent of all the deaths for which gallbladder disease either was responsible directly, or was an important contributory factor, nearly three times the anticipated incidence.

Diabetic patients fared poorly in the series of 337 gallbladder operations reported by Russo<sup>19</sup> in which diabetics constituted 11 per cent of the deaths and 2.6 per cent of the living group. The end results reported by McKittrick and Root<sup>17</sup> in gallbladder surgery on twenty-four diabetic patients was remarkably good in

COMMENTS

The fact that gallstones are found in cases of acute cholecystitis in a far greater incidence than that due to chance alone, suggests either a common etiology or else that the stones play some rôle in the acute process. Very commonly, stones are found wedged into the cystic duct causing local edema. Such a condition can, by interfering with blood supply, cause the pathologic processes known as acute cholecystitis. In a minority of cases, other obstructing factors such as anomalies, extrinsic pressure, etc., may produce the same condition. Experimental work tends to confirm these views.

Most patients have been suffering more or less from chronic gallbladder disease, usually cholelithiasis, before they develop acute and dangerous conditions. Rather than argue over the relative merits of early or delayed surgery in acute cholecystitis, it might be wiser to consider care-

Since antecedent gallbladder disease is usually present, this may indicate that severity of gallbladder disease is a direct function of chronicity of gallbladder conditions. Then again, the diminution of vascularity with increasing age and the fibrosis accompanying frequent attacks

TABLE X  
FEMALE DEATHS

| Pts. Initials | Age | W.B.C. on Admission | Cells/cu. mm. | ° Neut. | Duration of Recent Attack (Days) | Peak Preop. Temp. (Fahren). | Primary Final Diagnosis  | Contributory Diagnosis             |                   |             |          |           |            | Type of Operation | Class (See Text) | Total Duration GB Symptoms |
|---------------|-----|---------------------|---------------|---------|----------------------------------|-----------------------------|--|------------------------------------|-------------------|-------------|----------|-----------|------------|-------------------|------------------|----------------------------|
|               |     |                     |               |         |                                  |                             |  |                                    | GB Stones Present | GB Ruptured | Diabetic | Operation | Anesthesia |                   |                  |                            |
| J.M.          | 65  | 12,500              | 76            | 9       | 103                              |                             | 1. Ac. Empyema GB<br>2. Ac. Sup. Cholangitis                       | .....                              | yes               | no          | yes      | yes       | local      | -ostomy           | 1                | 20 years                   |
| B.M.          | 58  | 13,000              | 98            | 15      | 101                              |                             | Arteriosclerotic Heart Disease                                     | Ac. Empyema GB                     | yes               | no          | no       | yes       | spinal     | -ectomy           | 2                | 3 years                    |
| R.B.          | 62  | 11,000              | 75            | 52      | 103.8                            |                             | 1. Ac. Empyema GB<br>2. Ac. Sup. Hepatitis                         | .....                              | yes               | no          | yes      | yes       | spinal     | -ostomy           | 1                |                            |
| S.B.          | 55  | 18,500              | 92            | 19      | 104                              |                             | Ac. Empyema GB   | Arteriosclerotic Heart Disease     | ?                 | no          | no       | no        | .....      | .....             | 1                | Indefinite                 |
| S.R.          | 73  | 14,500              | 87            | 5       | 101                              |                             | Ac. Empyema GB   | Fatty Degeneration Liver and Heart | yes               | no          | no       | yes       | spinal     | -ostomy           | 1                |                            |
| E.M.          | 67  | 32,500              | 96            | 32      | 103                              |                             | 1. Ac. Empyema GB<br>2. Ac. Sup. Hepatitis                         | .....                              | yes               | no          | no       | no        | .....      | .....             | 1                | 1 month                    |
| M.M.          | 63  | 21,000              | 89            | 2       | 100                              |                             | Ac. Ant. Coronary Occlusion  | Ac. Empyema GB                     | yes               | no          | no       | yes       | ether      | -ostomy           | 3                | 2 days                     |
| F.H.          | 61  | 27,000              | 87            | 24      | 102                              |                             | 1. Diffuse Peritonitis<br>2. Duodenal Fistula<br>3. Ac. Empyema GB | Subac. Bact. Endocarditis          | yes               | yes         | no       | no        | .....      | .....             | 1                | 2 years                    |
| S.A.          | 56  | 12,900              | 75            | 3       | ...                              |                             | 1. Ac. Empyema GB<br>2. Gang. Abdom Wound                          | .....                              | ?                 | yes         | yes      | yes       | spinal     | -ostomy           | 1                | 3 days                     |

fully the prophylactic approach to the problem, i.e., the desirability of removing the gallbladder in all symptomatic cases of chronic cholelithiasis as a curative for symptoms and as a preventative for complications. Such a policy must be carefully evaluated in terms of morbidity and mortality which is beyond the scope of this paper. Certainly every case of acute cholecystitis that is allowed to subside should come to surgery after a reasonable interval, to preclude future more serious attacks which commonly occur.

It is interesting to note that if cases of acute cholecystitis are classed in groups in the order of increasing severity of disease, the average age increases for each group.

may favor widespread and serious damage with sudden vascular obstruction.

If one considers groups of patients, it is noticeable that the severity of the signs, symptoms and the degree of leucocytosis varies directly with the extent of the pathologic process. It is well recognized, however, that there are no pathognomonic findings for advancing gallbladder disease and that group averages must not be applied too strictly to individual cases. In fact, for any given patient it is not possible to correlate severity of signs and symptoms with the degree of disease present.<sup>10,13,24</sup>

Since cholelithiasis seems to be present in 80 to 90 per cent of all cases of acute

cholecystitis, a breakdown in the incidence of the one should approximately parallel a similar breakdown in the incidence of the latter. For example, the finding of stones in one and one-half times as many women as men was paralleled by a similar ratio in the cases of advanced gallbladder disease. In the diabetic group, a similar situation apparently exists for these patients totaled approximately 16 per cent both of the group with cholelithiasis and those with advanced gallbladder disease. This would tend to suggest that although diabetes mellitus is accompanied by a marked tendency for gallstone formation, there is no unusual tendency for these diseased gallbladders to progress to suppuration or gangrene. The exceptionally high mortality in these diabetic patients, however, suggests that they tolerate tissue destruction in the gallbladder as poorly as they do elsewhere. Diabetic patients, therefore, should not only be considered poorer risks for surgery in advanced gallbladder disease, but probably deserve more prophylactic surgery. The prophylactic cholecystectomy in diabetic patients with cholelithiasis is hardly a radical suggestion, appearing as it does in Joslin's popular text.<sup>14</sup> Rabinowitch<sup>18</sup> likewise urged gallbladder removal in these patients though he, like Joslin, was primarily concerned with the beneficial effects on the diabetic status.

#### SUMMARY

A series of eighty-two cases of empyema and/or gangrene of the gallbladder were reviewed from the standpoint of incidence, symptoms, signs and laboratory findings. The perforated cases were reviewed separately in a similar manner and comparisons made. No consistent significant differences were found other than an intensification of signs and symptoms. All the cases were also considered and discussed from the standpoint of surgery, gallstones and mortality.

The thirteen cases of diabetes mellitus were then analyzed separately. The mortality of these patients was found to be

much higher than that for the non-diabetic patients.

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# METATARSAL MARCH (FATIGUE) FRACTURES\*

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**M**ARCH or "fatigue" fracture is an occupational disease associated with military training. Although Meyerding and Pollock in 1938 described ten cases in civilians, seven of whom were women, and Zeitlin and Odessky, and Harmon have reported sporadic cases, the condition is extremely rare in civilian practice.

This paper deals with 259 cases of march fracture of the metatarsals, of which twenty-three were multiple, observed at a Station Hospital.

## HISTORY

In 1855, Breithaupt, a Prussian military surgeon, was the first to associate injury of the foot with the trauma of marching. He called it swollen foot. Various other authors, namely, Weisbach and Pauzat in 1877 and Martin in 1891 described a similar condition of the foot following marching. It was left to Stechow in 1897, following the advent of roentgenography, to demonstrate that the foot complaint described by earlier observers was due to a fracture of a metatarsal bone. This was confirmed by Schulte.

Since the first description of this condition by Breithaupt a voluminous literature has arisen. Strangely enough, although European literature was replete with references to this condition, American literature was particularly barren until the advent of World War II. Goldman, however, in 1928 was the first to describe this condition accurately in American literature. With the outbreak of present hostilities, contributions to American literature have been made by Sirbu and Palmer,

Henchell, Bosshardt, Meyerding and Pollock, Krause and Bowen, etc.

## ETIOLOGY

Numerous theories as to the mechanism of march fractures have been advanced by various authors, almost as many theories as authors who have written on the subject. Breithaupt, in 1855, attributed the disease to a traumatic tenosynovitis. Weisbach, in 1877, believed it was due to a tendonitis. Pauzat, in 1877, held that the government issued shoes of the French army, which had a dorsal fold, was a contributing factor. Martin, in 1891, thought the condition was due to a synovitis. Stechow, in 1897, demonstrated a metatarsal fracture. He and Kirschner attributed the condition to abnormal stresses and strains causing periosteal reaction and callus formation. In 1921, Deutchlaender concluded that the condition was due to a hematogenous bacterial periostitis with callus formation. In 1926, Murk Jansen believed that march fractures were due to an ischemic phenomenon resulting from spasm of the interossei leading to vascular obstruction and edema of the periosteum and soft tissues. This in turn caused decalcification of the defective bone rendering it liable to fracture and was followed by secondary deposit of new bone in the same area. McMurray, in 1937, believed the disorder was due to metatarsalgia, i.e., a flattened short tarsal arch. Krause, in 1942, believed that prolonged and repeated foot strain resulted in rhythmically repeated subthreshold mechanical insults acting by summation to a point beyond the capacity of the bone to bear

\* The data offered in this paper represent the author's military experience when on active duty with the Medical Corps.

the stress. Morton, in 1927, 1928, 1930, and 1935, Dodd, in 1933, Sirbu and Palmer, in 1942, Geoffrey Flavell, in 1943, stressed the anomalous development of the foot

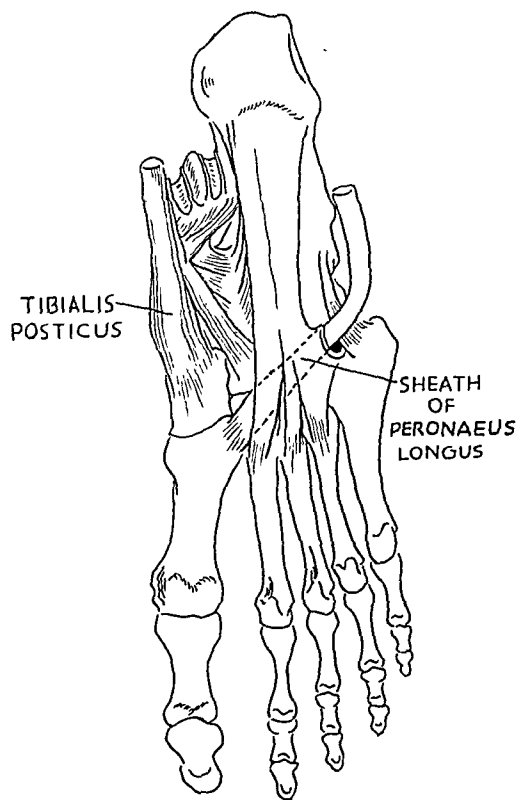


FIG. 1. Anatomy of foot, demonstrating the "sling" formed by tibialis posterior and peroneus longus tendons.

as a predisposing cause resulting in a shift of weight from the first to the second or third metatarsal bone which were unsuited to bear the load.

Because such great importance in recent literature has been placed upon the anomalous foot as a contributing factor of march fractures of the metatarsals it might be well to examine a series of cases in the light of the so-called atavistic or Morton's foot. It is the belief of the author that the most important factor in the incidence of metatarsal march fractures is fatigue of the peroneus longus and tibialis posterior muscles rather than the length and disposition of the metatarsal bones. The tibialis posterior tendon sweeps around the medial aspect of the foot and is in-

serted on the plantar aspect of the navicular, first, second, and third cuneiform bones with slips passing to the sustentaculum tali and cuboid. The peroneus longus tendon passes from the lateral aspect of the foot along the plantar surface and is inserted into the base of the first metatarsal and second cuneiform bones. Thus these two tendons form a sling which assists in the support of the long plantar arch. (Fig. 1.) Notwithstanding the belief of Sirbu and Palmer, who state that march fracture "occurs in young soldiers unused to rigors of long marches but only in those whose feet are inherently weak or flat," the author finds that of 259 metatarsal march fractures, in 105 cases in which the condition of the foot was noted, fifty-nine patients had normal feet, fifteen had pes planus one degree, fourteen had pes planus two degrees, and seventeen had pes cavus. It is obvious from these figures that metatarsal march fractures occurred chiefly in soldiers with normal feet, or in soldiers with slight degree of pes planus or in those with pes cavus. No case of march fracture was found associated with marked degrees of pes planus. This is in keeping with the contention of the author that the normal foot depends upon the tibialis posterior and peroneus longus for support, but due to the fatigue of these muscles the metatarsals are compelled to take the full weight of a man's body and his field pack. Conversely in marked degrees of pes planus the metatarsals are conditioned to direct weight bearing and they can get along without the support of these two tendons and so are not subject to fracture as frequently.

Bruce states that the normal metatarsal segment is one in which the five metatarsal bones are arranged in parallel formation with the head of the first metatarsal on the same transverse plane or even a little more distal than that of the second. All deviations from this are atavistic. In the ideal foot the first metatarsal is completely adducted and equals in length the longest of the digital segment. It undergoes

hypertrophy and has the stoutest of the five shafts. The other metatarsals decrease in length and their shafts become almost parallel.

metatarsal, and in twenty-two cases the first metatarsal was longer than the second. When comparing the length of the first metatarsal with the third metatarsal in

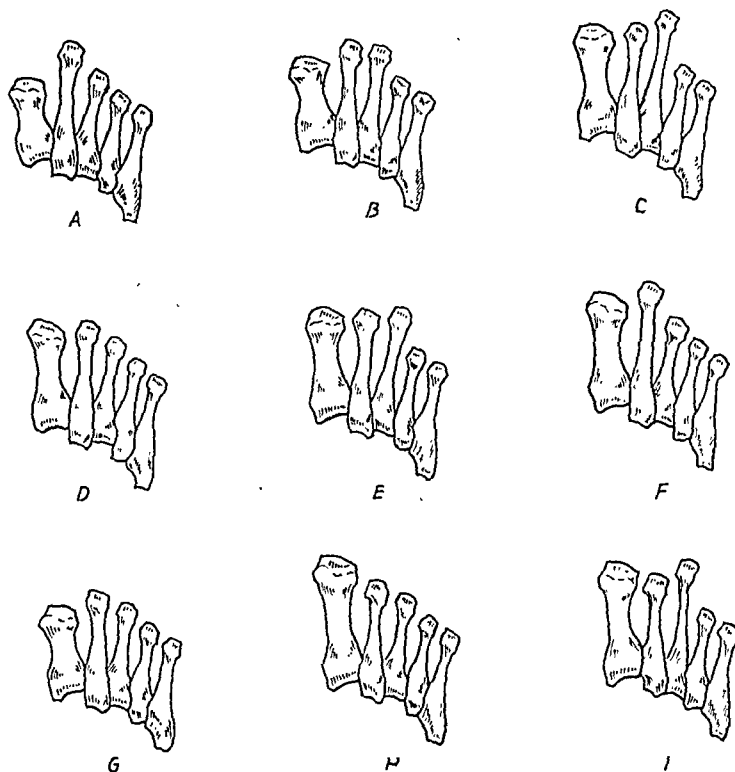


FIG. 2. Arrangement of metatarsal segment in relation to site of fracture.

NO. OF TIMES FRACTURED, METATARSALS

|   | First | Second | Third | Fourth | Fifth |
|---|-------|--------|-------|--------|-------|
| A | 3     | 21     | 38    | 6      | 3     |
| B | ..    | 1      | 1     | ..     | ..    |
| C | ..    | 2      | ..    | ..     | 3     |
| D | 1     | 18     | 22    | 3      | 1     |
| E | ..    | 9      | 7     | 1      | ..    |
| F | ..    | 2      | 5     | ..     | ..    |
| G | 1     | 25     | 59    | 7      | ..    |
| H | ..    | 9      | 9     | 1      | ..    |
| I | ..    | ..     | ..    | ..     | 1     |

Flavell claims that any of the extremely common atavisms cause a shift of stress to the second and third metatarsals and are contributory factors in the etiology of metatarsal march fractures. However, in 259 cases, 171 first metatarsals were shorter than the second, sixty-six first metatarsals were equal to the second

259 cases, seventy-six first metatarsals were shorter, 114 were equal, and sixty-nine were longer than the third metatarsals. In 259 cases, the longest bone of the metatarsal segment was fractured in seventy-seven cases, and in 174 cases, the fracture involved a metatarsal which was shorter than one or more of its fellows; in

eight cases, another metatarsal was equal in length to the fractured metatarsal. In fractures of the first, fourth, and fifth



FIG. 3. Relationship of fracture to thinness of metatarsal bone. A, thinnest metatarsal, ninety-six cases; B, other than thinnest metatarsal, 163 cases.

metatarsals comprising thirty-one cases one or more metatarsals were longer than the fractured bone. In the case of eighty-seven fractures of the second metatarsal, the second was the longest segment in forty-eight cases, was shorter in eleven cases, and was equal in length in twenty-eight cases. In 141 fractures of the third metatarsal, the third was shorter in 133 cases than another component of the metatarsal segment, was equal in eight cases, and in no case was longer than one or more of its fellows. It appears from this that if the second metatarsal is longer and protrudes beyond the other segments it is apt to be the site of fracture. In the case of the third metatarsal, the commonest site

of march fractures, in not one case did the involved third metatarsal project beyond, and in only eight cases did it equal one of its fellows in length. Hence the atavistic foot does not appear to be an important predisposing cause of fracture. (Fig. 2.)

It might appear that the thinnest metatarsal would be subject to fracture most often. However, in 259 cases, the thinnest metatarsal was involved in ninety-six cases, and in 163 cases, a metatarsal other than the thinnest was fractured. (Fig. 3.)

Does a man's pre-induction occupation play a part in etiology? I do not believe that it does. In 121 cases, in which occupation of the trainee was investigated, 53 per cent followed sedentary occupations and 47 per cent an active occupation; however, the rigorous training of military life is such that even the most vigorous civilian occupation is not its equal. A man following an active occupation or participating in an active sport can rest when fatigued, whereas in military training a soldier is expected to continue on his march even if greatly fatigued. The good physical condition of a man entering the army would tend to prevent early fatigue, but a very small percentage of men can stand the rigors of a 25 mile march in eight hours, for example, without a greater or lesser degree of fatigue. It is interesting to note that most of our march fractures of the metatarsals occurred in the second to fourth month of training, when the training program was most strenuous.

#### INCIDENCE

At a Station Hospital, from September 1, 1943, to May 30, 1944, a period of nine months, 996 orthopedic cases were hospitalized and 9,957 orthopedic cases were seen by our consultation service, a total of 10,953 cases. Metatarsal march fractures comprised 259 cases or 2.35 per cent. The right foot was involved 154 times and the left foot 105 times. (Figs. 4 and 5.) In five march fractures of the first metatarsal, two occurred in the right foot and

three in the left foot; in eighty-seven march fractures of the second metatarsal, fifty-one cases occurred in the right and thirty-

in eight cases of involvement of the fifth metatarsal, four occurred in each foot.

Twenty-three cases of multiple march

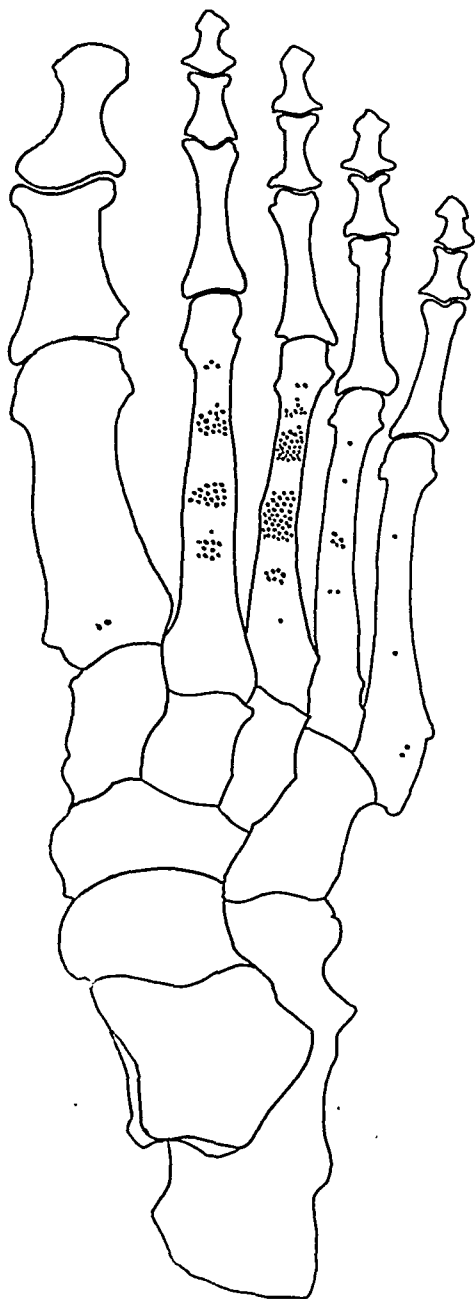


FIG. 4. Distribution of march fracture, right foot.

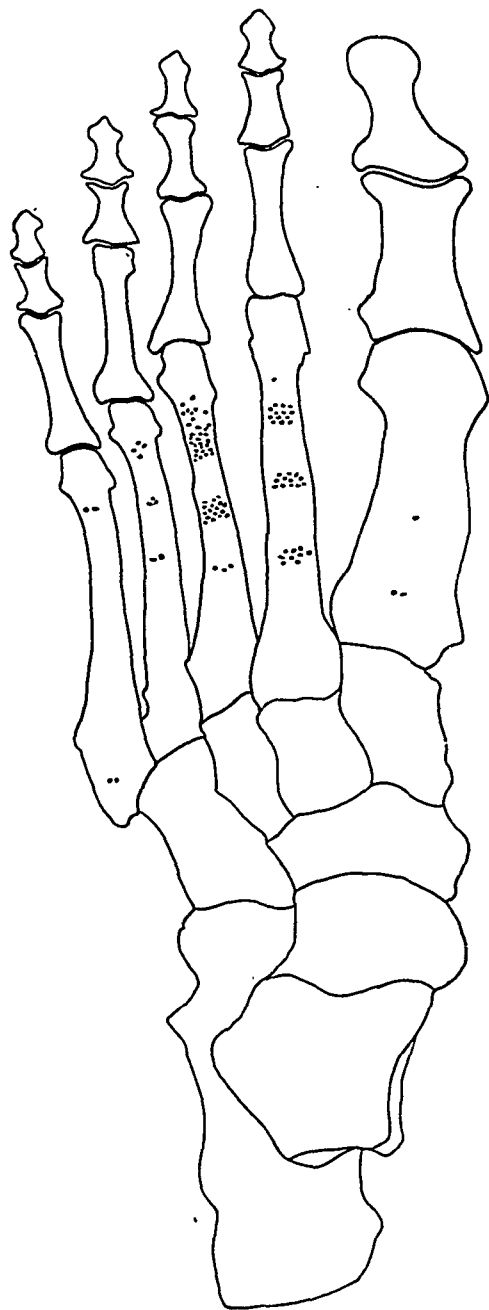


FIG. 5. Distribution of march fracture, left foot.

six in the left; in 141 third metatarsal, march fractures, eighty-eight occurred in the right and fifty-three in the left foot; in eighteen cases of fourth metatarsal fractures, nine cases occurred in each foot;

fractures were encountered; four cases involved the second metatarsal of each foot; in two cases, the third metatarsal of each foot; in one case, the second and fifth metatarsal of the right foot; in two cases,



the second and third metatarsals of the left foot, and in six cases, the second and third metatarsal of the right foot; in three

Twenty-one cases showed angulation of fragments, 120 cases did not. In 108 cases the fracture was complete; in thirty-three

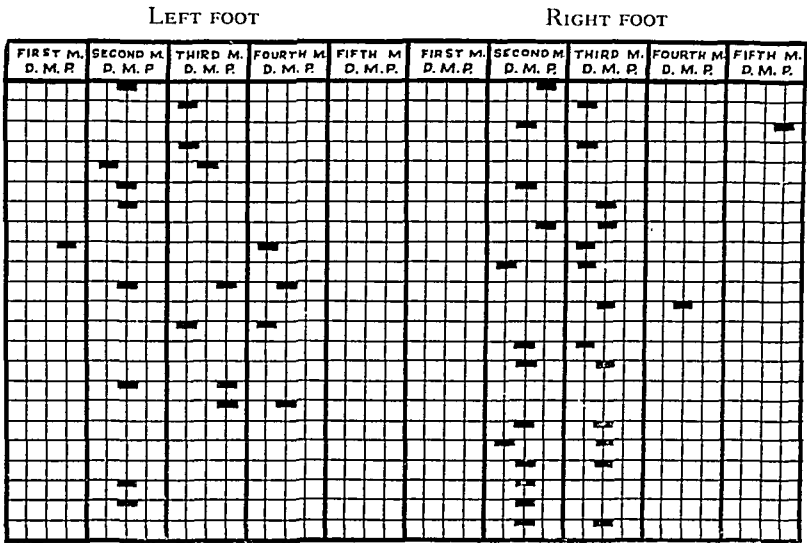


FIG. 6. Distribution of twenty-three multiple march fractures. D, distal third; M, middle third; P, proximal third.

cases, the left second and the right third; one case involved the left first and fourth and right third metatarsal; in one case, left second, third, and fourth metatarsal; the left third and fourth were involved twice and the right third and fourth once. (Fig. 6.)

SITE OF FRACTURE

In the first metatarsal, the base was involved four times, the middle third once. There was no displacement of the fragments. Two fractures were complete, three incomplete. In the second metatarsal, thirty-one cases involved the junction of the middle and distal third; twenty involved the junction of the proximal and middle thirds; the neck was involved five times; the middle third was involved thirty times. Eight cases showed angulation of fragments, seventy-nine cases did not. In sixty-six cases fracture was complete and in twenty-one incomplete. In the third metatarsal fifty-one cases involved the junction of the middle and distal thirds; ten cases the proximal and middle thirds; twenty-one cases the neck; and in fifty-nine cases the midshaft.

incomplete. In the fourth metatarsal the junction of the middle and distal thirds was involved four times; the junction of the proximal and middle thirds two cases; the neck five cases; mid-shaft seven cases. Four cases showed angulation, fourteen cases had no displacement. Fracture was complete in fifteen cases, incomplete in three cases. In the fifth metatarsal the junction of the middle and distal thirds was involved in one case; the junction of the proximal and middle thirds one case; the neck two cases; and the base in four cases. Two cases showed angulation, six did not. In all eight cases fracture was complete.

To recapitulate, of 259 cases the fracture was complete in 199 cases and incomplete in sixty cases. (Fig. 7.) Of the same number of cases, in 224, there was no displacement of the fragments and in thirty-five some displacement. (Fig. 8.)

AGE

The highest percentage of fractures occurred in the eighteen and nineteen year old group of trainees. This was due in large

measure to the fact that the greatest number of our trainees were in that age group. (Fig. 9.) Metatarsal march fractures occur

#### CLINICAL COURSE

The patient is usually a trainee about eighteen or nineteen years old with about

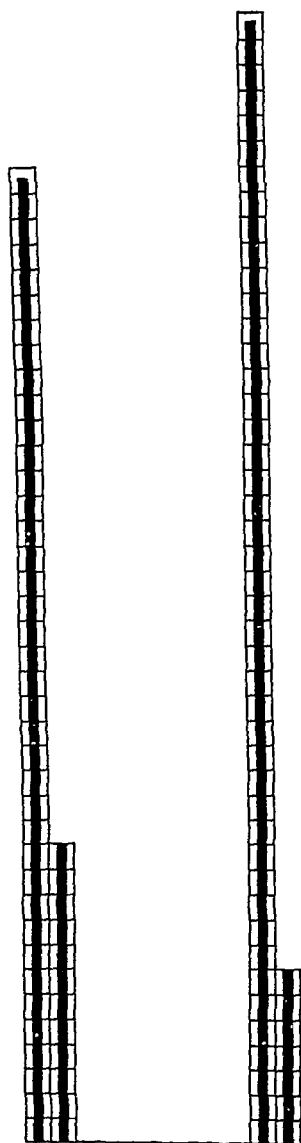


FIG. 7. Complete fractures versus incomplete fractures; 199 complete; sixty incomplete.  
FIG. 8. Fractures without displacement versus fractures with displacement; 224 without, thirty-five with displacement.

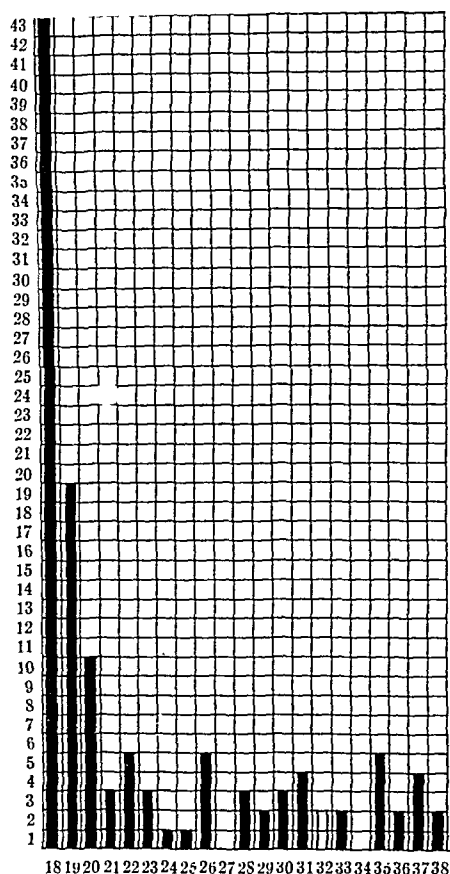


FIG. 9. Age distribution of metatarsal march fractures.

in all age groups, the oldest being thirty-eight years. It is my belief that age plays no great part in the incidence of march fractures.

four to twelve weeks service. He complains of pain in the fore part of the foot and generally states that he was on a long or forced march when he experienced pain. This pain is insidious in its onset or came on acutely. It is not usually very severe and the soldier is able to continue with his march. This, of course, varies with the individual's pain threshold level. That evening the soldier may notice slight swelling on the dorsum of the foot. Taking the weight off the foot relieves the pain. In some cases the soldier may not be greatly inconvenienced and he may complete all phases of his seventeen-week training cycle. The longest period of complaint was eighty-four days before march fracture could be demonstrated; the shortest period

was one day before hospital entry. The average length of time from date of injury to hospitalization in 121 cases was 15.4 days.

On physical examination there is slight swelling on the dorsum of the foot. Point tenderness is present over the involved metatarsal. Motion of the toe causes pain. No crepitation is generally elicited.

X-ray may show slight periosteal thickening without fracture, usually in the second and third metatarsal. When fracture involves the first metatarsal it occurs at the base and is of the "ice-crack" type. X-ray findings vary with the age of the injury. Early in the first week there may be merely periosteal elevation and thickening. In some cases there is a small crack through the cortex and in others there may be complete fracture. With the history of a long march and pain localized over the metatarsal bones, a negative x-ray is not conclusive. A recheck is indicated in about a week. Following the first week there may be diffused thickening of the periosteum without obvious fracture, or as is more common, the fracture extends through the entire thickness of the bone. One of the characteristics of metatarsal march fractures is the large, fluffy or cottony callus that is present at the fracture site. This, however, is not true of fractures involving the neck. In this locality there is slight production of callus. The fluffy appearance of the callus makes this condition easily mistakable, by the uninitiated, for an osteogenic sarcoma or a Ewing's tumor. After four to six weeks the callus becomes organized and a fusiform swelling is present at the site of the fracture. Angulation at the fracture site is not common but may occur.

With hospitalization, after four to six days of bed rest, the swelling and pain subside. At this Station Hospital, soldiers with march fractures are kept at bed rest for three weeks. To prevent too much loss of training, they are sent to the reconditioning program for two to four weeks, and at the end of this period are returned to full duty.

In a small percentage of cases some patients complain of pain in the foot three or four months after injury. This can be attributed to, first, the attitude of the soldier toward military training, secondly, the soldier's pain threshold, and thirdly, excessive callus formation, which is comparatively uncommon.

A number of my patients were allowed weight bearing on the heel after pain and swelling subsided, i.e., in seven to ten days. My impression is that there is no appreciable difference in the amount of callus formation at the fracture site in patients who are kept at bed rest for the entire period of three weeks or when early heel weight bearing is permitted. A patient with a painful foot voluntarily restricts the amount of weight placed on that foot. No case of non-union and extremely rare cases of slow union were observed. It appears that metatarsal fractures are comparable to fractures of the humerus, treated by hanging-case method, in that incomplete immobilization and motion at the fracture site does not delay or prevent union. This is best explained on the basis of the excellent blood supply. In none of my cases was the foot immobilized in plaster.

#### PROGNOSIS

Approximately 99 per cent of these patients made a good recovery without further disability or pain, returned to training and eventually to full military duty. None of the patients required discharge from the army because of disability exclusively attributable to march fracture of the metatarsal alone.

#### SUMMARY

1. Metatarsal march fracture is primarily an occupational disease of soldiers.
2. The author believes that metatarsal march fractures are caused by fatigue of the peroneus longus and tibialis posticus muscles.
3. March fractures are more properly termed fatigue fractures. There is no basis

for the belief, as some authors have indicated, that metatarsal march fractures are due to spasm and overactivity of the interossei muscles.

4. The presence of an atavistic foot as an etiological factor of metatarsal march fracture is greatly over-rated.

5. All of the metatarsal march fractures in this series which were investigated occurred in soldiers with normal feet, or in cases of slight degree of pes planus and in cases of pes cavus. Not a single case of severe pes planus was encountered.

6. Pre-induction occupation of the soldier does not appear to be a decisive element except insofar as the tolerance of fatigue may be concerned.

7. The thinness of the metatarsal bone plays no important rôle in the etiology of metatarsal fractures as more fractures occurred in metatarsal bones other than the thinnest.

8. All age groups from eighteen to thirty-eight were involved in metatarsal march fractures but the eighteen and nineteen year old group were chiefly affected.

9. March fractures of the metatarsals involved all bones of the metatarsal segment but chiefly the second and third of the right foot.

10. Twenty-three cases of multiple metatarsal march fractures were encountered.

11. Fractures of the metatarsal bone involved 2.35 per cent of 10,953 cases seen by the Orthopedic Surgical Section at our Station Hospital.

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# CHLOROPHYLL AND ADRENAL CORTICAL EXTRACT IN THE LOCAL TREATMENT OF BURNS\*

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THE early treatment of severe burns is primarily concerned with the relief of pain, the restoration of normal osmotic equilibrium, and the maintenance of physiological water balance, but choice of local treatment is usually a matter of personal opinion based on individual experience. With small burns the local treatment becomes of primary importance, and herein lies most of the present disagreement as to method of choice. The therapeutic armamentarium for burns is, at the present time, one of the largest collection of diverse substances ever propounded for one human ailment; and the vastness of it testifies to the fact that none of the methods are completely satisfactory.

During the past few years, my interest has been concerned with the evaluation of the more promising agents in regard to their local value in the treatment of burns.<sup>2</sup> Local treatment may seem insignificant by comparison to the systemic problems of burns of large areas, but local treatment is, nevertheless, an important aspect of all burns. It is only in the small burns that the effects of hemoconcentration, fluid loss, shock, etc., are at a minimum; purely local physiological processes of healing can be observed; and treatments of physiological sanity can be devised. It is hoped that knowledge so gained may be of great value also in the local treatment of large burns.

I am in complete agreement with Smith and Livingston who state, " . . . it is well to adopt a conservative and frankly skeptical point of view regarding the relatively extravagant claims of each enthusiastic contributor to the rapidly growing chemotherapeutic armamentarium avail-

able for the treatment of burns and other traumatic injuries."<sup>22</sup> The following experimental results are given, then, not to propound a spectacular new cure for all burns, but with three objects in view: (1) To emphasize the fact that we have too often, in our treatment of burns, overlooked or underestimated the importance of the physiological and pathological changes at the site of injury. (2) To present evidence which seems to indicate that adrenal cortical hormone has considerable value in the local treatment of burns and to stimulate further studies on this subject. (3) To present, for what it may be worth to industrial surgeons, a method that has been most satisfactory here in industrial work.

Before beginning to repair anything, whether it be some mechanical contrivance or body injury, it seems to me that one should acquaint himself with what has happened in and to the part to be repaired. This may seem trite, but the lack of such knowledge is in part responsible for our innumerable methods for treating burns. In order to understand what has happened in a burned area, one must have a knowledge of the physiological and pathological occurrences following tissue injury and in tissue repair. For this knowledge we are indebted, for the most part, to Menkin and his classical works on the subject.<sup>14,15,16</sup> Menkin has shown that there is a basic pattern of reaction at the site of a wound regardless of the type of injury, although the ultimate appearance may be influenced by the causative agent or the anatomical location. First, there is increased fluid passage from the blood to the exterior of the capillaries referable to the liberation of

\* From the Bethlehem Steel Company, Sparrows Point Hospital, Sparrows Point, Md.

leukotaxine which increases capillary permeability. Second, fibrinogen of the proteins which escape with the fluid is precipitated as a fibrinous network. Being evidently more delicate, the fine lymphatics are damaged early and become occluded with fibrinous thrombi. The presence of the occluded lymphatics and of the precipitated fibrinogen produce a "walling off" of the inflammatory irritant. Third, polymorphonuclear leukocytes appear as a result of the chemotactic action of leukotaxine. The normal sequence of polymorphonuclears followed eventually by macrophages is controlled by the hydrogen ion concentration at the site of inflammation, and the developing local acidosis is in turn referable to disturbed carbohydrate metabolism. Fourth, an increase in number of circulating leukocytes occurs due to the liberation of a pseudoglobulin known as "the leukocytosis promoting factor." Fifth, the foregoing sequence of events ultimately leads to disposition of the irritant and allows tissue repair.

In addition, it has been found that the actual injury factor, termed "necrosin," is an euglobulin or is, at least, associated with this protein fraction.

We also have some rather definite information at hand from experience in the treatment of burns. We know that, with few exceptions, a simple sterile ointment of vaseline or other greasy base allows kindly healing and simplicity of application. The latter is of considerable importance in industrial work where industrial nurses are employed in numbers. We know that burns are especially prone to infection. It is also apparent that the actual repair of destroyed tissue is probably dependent upon the formation of one or more growth stimulating factors.

Considering this information, we may set up six cardinal requirements that we would like to meet when compounding a preparation to be used locally on burns. These requirements are basic and must be met by any agent if it is to be at all satisfactory in aiding healing: (1) Relieve pain

and present a comfortable dressing for the wound; (2) be suitable in ease of application and removal to the abilities of the person who is to use it; (3) not produce further tissue damage; (4) reduce or preferably prevent entirely the increased fluid passage from the capillaries; (5) produce stimulation of tissue repair, and (6) prevent infection.

As has been stated heretofore, requirement number 1 will be satisfactorily met by a simple vaseline ointment. After many years of use on thousands of burns in the Bethlehem Steel Company's Clinics, the following preparation has been found quite satisfactory.

#### BI OINTMENT

|                         |           |
|-------------------------|-----------|
| Bismuth subnitrate..... | 33.5 gr.  |
| Paraffin.....           | 44.5 gr.  |
| Yellow petrolatum.....  | 559.5 gr. |

Bi ointment also satisfies requirement number 2 as its application or removal is one of the simplest and quickest of operations. There is no evidence that further tissue damage is produced by this ointment; therefore, we do not have objections from requirement number 3.

Since the increased capillary permeability present in a burn is caused by leukotaxine, it is evident that we must counteract the effects of leukotaxine in some way in order to meet requirement number 4. The search for some such substance has been carried on here during the past few years.

Menkin<sup>15</sup> and Freed and Lindner<sup>3</sup> have noted that adrenal cortical extract held the action of leukotaxine in abeyance, and Rhoades, Wolff, and Lee<sup>21</sup> have stated that the return of capillary semi-permeability after a burn was more rapid when adrenal cortical extract was given to the patient. Desoxycorticosterone has a similar but less pronounced effect, and ovarian steroids do not produce this effect.<sup>5</sup> In addition, there has been a great deal of work on the use of adrenal cortical extract in the treatment of shock. However, in all of these instances its use has been by

parenteral injection. To my knowledge, it has not been used locally where it might be most effective. Experimental results on its use locally added to Bi ointment will be given in succeeding paragraphs. There is much to indicate that by adding this hormone, or group of hormones, to the simple Bi ointment, requirement number 4 will be met.

It has been shown rather conclusively that, of all the agents at present available for the stimulation of cell proliferation and tissue repair, chlorophyll probably has the most constant and marked effect. Hence, it seemed advisable to add this agent to the burn ointment in order that we might achieve maximum tissue repair in the shortest possible time. To date, its use by other investigators has been limited, but results have been excellent. Therefore, in order to meet requirement number 5, chlorophyll has been added to the formula, and as will be shown, the results have not been disappointing.

With careful initial technic and the utmost care in redressing burns, the problem of infection (requirement 6) may be solved in the majority of cases. Nevertheless, it is quite comforting to have a bacteriostatic or antiseptic agent at the site of burn to aid in control of infection. Probably this fact more than any other has led to the great numbers of agents in use at the present time. All have advantages and disadvantages. The sulfonamides have received their share of attention in this field, and one would be tempted to add a member of this group to our hypothetical ointment. However, the local use of sulfonamides is not by any means devoid of dangers and disadvantages. For this reason, I have not included a sulfonamide drug, but have relied on the bacteriostatic effect of chlorophyll and on careful technic to maintain a relatively sterile wound. Chlorophyll, to be sure, is not a true antiseptic nor is it a strong bacteriostatic agent, but as will be demonstrated, it will produce sufficient effect to obviate the necessity for a stronger agent or a sulfonamide

drug. In addition, it has the advantage of not producing further tissue damage.

From a theoretical standpoint, we have an ointment that should meet all the requirements that we have enumerated. The agents chosen seemed to be the most promising for each requirement, and we have added adrenal cortical extract on a completely theoretical basis. It remained to be seen whether the results anticipated would be clinically evident. Three ointments were compounded:

1. Bi Ointment (formula given previously).
2. Bi Chlorophyll Ointment  
This consisted of the plain Bi ointment to which had been added the water soluble fraction of chlorophyll\* to the extent of 1 per cent by weight.
3. Bi Chlorophyll Adrenal Ointment  
This consisted of Bi chlorophyll ointment to which had been added adrenal cortical extract† to the extent of 2¼ per cent by weight.

Ninety-one cases of industrial burns were treated with these ointments as a preliminary trial. Cases were chosen at random for the various treatments except where comparable bilateral areas were burned, in which case, one area was treated by one method and the other area by a different method for comparison. The wounds ranged in size from small second and third degree spot burns to first, second, and third degree burns of 150 to 175 square inches, and were produced by a wide variety of agents. In all cases the ointment was spread on sterile cotton lint cloth and the cloth was applied to the wound ointment side down. When possible, a firm gauze bandage held this dressing in place; otherwise, adhesive tape was used to maintain apposition of the dressing. Admittedly, the number of cases is not large, but the results were sufficiently impressive that it was believed advisable to report them in order that others who may have an opportunity might become interested in giving these agents further clinical trials. In the following tables the

\* Courtesy Rystan Company, New York, N.Y.

† Upjohn—50 dog units per cc. (purchased on the market).

burns have been classified according to depth of destruction as first, second, and third, degree, and in addition, all deep second degree spot burns have been placed in a separate classification because of their characteristically poor healing.

control group, but with the deeper burns (second degree spot and third degree) there was considerable decrease in healing time which can be attributed only to the chlorophyll as this was the only agent present which was not also in the control.

TABLE I

|                                    | Bi Ointment |      |           |      | Bi Chlor. Oint. |      |           |      | Bi Chlor. Adr. Oint. |      |           |      |
|------------------------------------|-------------|------|-----------|------|-----------------|------|-----------|------|----------------------|------|-----------|------|
|                                    | 1st.        | 2nd. | 2nd. Spot | 3rd. | 1st.            | 2nd. | 2nd. Spot | 3rd. | 1st.                 | 2nd. | 2nd. Spot | 3rd. |
| Degree.....                        |             |      |           |      |                 |      |           |      |                      |      |           |      |
| Average size (sq. inches).....     | 41.9        | 28.8 | .78       | 3.0  | 32.5            | 9.0  | 1.3       | 1.5  | 26.7                 | 21.0 | .8        | 1.0  |
| Observed healing time (days).....  | 10.4        | 16.0 | 13.6      | 86.0 | 8.7             | 8.9  | 13.0      | 26.7 | 6.7                  | 8.0  | 6.0       | 15.0 |
| Expected* healing time (days)..... | 10.4        | 16.0 | 13.6      | 86.0 | 8.1             | 5.5  | 21.8      | 43.0 | 6.7                  | 11.8 | 14.1      | 23.7 |

\* Based on the time that a similar size burn would have been expected to heal if treated with Bi Ointment.

TABLE II

|   | Bi Ointment |      |           |      | Bi Chlor. Oint. |      |           |      | Bi Chlor. Adr. Oint. |      |           |      |
|---|-------------|------|-----------|------|-----------------|------|-----------|------|----------------------|------|-----------|------|
|   | 1st.        | 2nd. | 2nd. Spot | 3rd. | 1st.            | 2nd. | 2nd. Spot | 3rd. | 1st.                 | 2nd. | 2nd. Spot | 3rd. |
| Infection rate per cent.....                    | 0.0         | 18.0 | 25.0      | 28.0 | 0.0             | 0.0  | 0.0       | 0.0* | 0.0                  | 0.0  | 0.0       | 0.0  |
| Loss of fluid (per cent of cases in each group) |             |      |           |      |                 |      |           |      |                      |      |           |      |
| None.....                                       | 100         | 15   | 33        | 0    | 100             | 12   | 0         | 34   | 100                  | 64   | 100       | 0    |
| Slight.....                                     | 0           | 50   | 42        | 90   | 0               | 44   | 0         | 33   | 0                    | 36   | 0         | 96   |
| Moderate.....                                   | 0           | 26   | 17        | 10   | 0               | 44   | 0         | 33   | 0                    | 0    | 0         | 4    |
| Marked.....                                     | 0           | 9    | 8         | 0    | 0               | 0    | 100       | 0    | 0                    | 0    | 0         | 0    |
| With fluid loss time to dry (days)....          | ...         | 8.6  | 8.8       | 10.1 | ...             | 4.5  | 5.0       | 9.0  | ...                  | 2.7  | 3.0       | 5.0  |

\* One case infected when Bi chlorophyll ointment applied—rapidly cleared of infection.

In Table I are given the results of these experiments in regard to healing time. Burns were considered healed when completely epithelialized, non-tender, and non-inflammatory so that no dressing or protection was necessary. Using the healing time per square inch for each type of burn in the control group (Bi ointment) as standard, expected healing times were computed for the other two groups so that figures might be comparable as regards size of burn.

Considering Bi chlorophyll ointment, it will be noted that there was no beneficial effect on healing time of first, and second degree burns over and above that of the

Considering Bi chlorophyll adrenal ointment, there was no beneficial effect on first degree burns, presumably because the skin here remains impervious to these agents, and their local application is without effect. However, all other burns, where there was opportunity for absorption, (second degree, second degree spots, and third degree) were healed much more rapidly than expected, and the reduction in healing time was even greater than that produced by Bi chlorophyll ointment.

In Table II are given other measures of the effectiveness of these ointments.

*Infection.* Cultures were not taken. By infection is meant grossly observable in-



fection: purulent exudates, local elevation of temperature and inflammation in excess of that expected for the size burn, lymphangitis if present, and other clinically evident signs. Undoubtedly, most of these burns were not bacteriologically sterile, but the classification is sufficiently exact for the purpose here. Note in Table II that the clinical infection rate was zero in all burns treated with ointments containing chlorophyll, and also note that the addition of adrenal cortical extract did not interfere with chlorophyll in this effect. All burns were treated with the same surgical technic. No débridement was done except for the removal of completely separated tissue and where otherwise necessary to combat infection. It has been the experience here that the operative removal of blistered or devitalized intact tissue is not advantageous and often is actually detrimental to healing.

Fluid loss at the site of the burn. The fluid lost from the site of a burn cannot readily be collected and measured, but an effort was made to estimate it by observing the following factors: (1) The amount of fluid present under blisters, (2) severity of the local edema, and (3) the amount of fluid absorbed in the dressings. On the basis of these observations the burns were classified according to fluid loss as none, slight, moderate, and marked. In addition, the length of time required for the burn surface to dry was recorded. On the basis of these findings it is believed that a reasonably accurate comparison of the different treatments can be made. These figures are given in Table II. It will be noted that Bi chlorophyll ointment had little or no effect on fluid loss, whereas there was a definite and marked decrease of amount and severity of exudation when adrenal extract was used (Bi chlorophyll adrenal ointment). There were several cases with bilaterally similar burns in all of which the side treated with Bi chlorophyll adrenal ointment lost less fluid and dried much sooner than the control side. If these results are verified by others in the treat-

ment of larger burns, adrenal extract may prove to be of value in reducing the amount of intravenous plasma used in burns.

#### CONCLUSIONS AND COMMENTS

Much larger series of cases are necessary before any of these findings may be considered fact, but the following observations seem to be justified at this time:

1. In the first degree burns the skin does not absorb appreciable quantities of either chlorophyll or adrenal cortical extract, so that no beneficial effects are encountered in the addition of these agents to a simple vaseline ointment.

2. Epithelial proliferation and wound healing are definitely accelerated by the local application of chlorophyll, and this is in all probability due partially to its bacteriostatic effect. Using ordinary aseptic precautions, chlorophyll is the only agent necessary for the maintenance of a surgically clean wound.

3. Adrenal cortical extract applied locally, reduces the local edema and fluid loss from a burned surface, aids drying, and promotes healing. Theoretically, the mechanism of this action is its inhibitory effect on leukotaxine. It remains to be seen just how profound this effect will be on burns of larger areas.

4. Débridement of burns as ordinarily practised is not necessary and may be actually harmful in many cases.

5. The following method of preparation of Bi chlorophyll adrenal ointment has been found very satisfactory for combining the effects of a greasy base with chlorophyll and adrenal cortical extract, and has been very satisfactory for industrial uses.

Bismuth ointment containing bismuth subnitrate 33.5 gr., paraffin 44.5 gr., and yellow petrolatum 359.5 gr. to the ounce may be purchased in desired quantities. The consistency can be controlled by the amount of paraffin or petrolatum added to this ointment. Here, we add about 200 gr. of yellow petrolatum to the ounce. This mixture is then Bi ointment as referred to

heretofore. To a weighed amount of this ointment is added 1 per cent of chlorophyll by weight. The mixture is autoclaved, allowed to cool, and may be stored for long periods of time. Adrenal cortical extract is added to the extent of  $2\frac{1}{2}$  per cent by weight, and the mixture is stirred with a sterile spatula until homogenized. The stability of adrenal extract in this ointment is not known, and until such information becomes available, the final ointment should be made up fresh every four to five days.

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# ESOPHAGEAL DIVERTICULUM\*

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“THESE developments have been variously called esophageal diverticula, pharyngo-esophageal diverticula or

tween the pars obliqua and pars fundiformis of the cricopharyngeus muscle (inferior constrictor of the pharynx), just

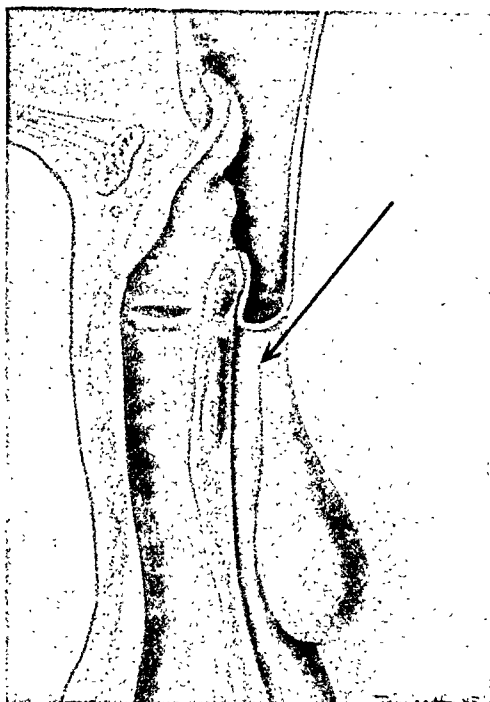


FIG. 1. Danger point perforation.

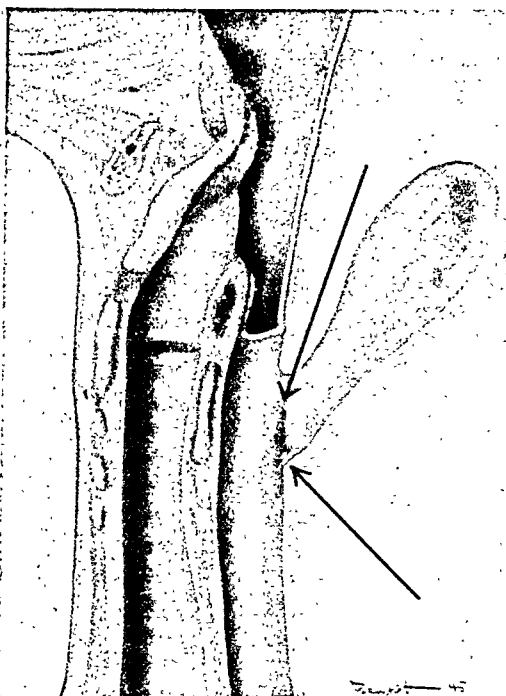


FIG. 2. Neck really not dissected; recurrence the result.

pouches; pressure pouches, pharyngoceles; or retrocricoid pharyngeal diverticula. It is now known that their site of origin is always the same—in the median line of the posterior wall of the esophagus in the hypopharynx directly opposite or immediately below the cricoid. Actually they arise just above the beginning of the esophagus. The pouch, which projects from the posterior aspect of the esophagus on the left side, is made up of the mucous and submucous layers of the pharynx. It bulges through a transverse opening forced be-

above the beginning of the esophagus. Formerly thought to be embryonic, they are now considered to be due to mechanical pressure.” This discussion does not include traction diverticula which as a rule rarely cause symptoms.

The area of the esophageal diverticulum should be fluoroscoped to determine in which direction the sac extends, i.e., to the right or left side. The incision should naturally correspond to the side of the neck in which the sac protrudes. Fluoroscopy is important since in some cases the

\* Presented before Annual Meeting of the Society of Surgeons of New Jersey, January 31, 1945.

sac may project into the right side of the neck, and if the usual left approach is employed one will find himself in difficulty.

The inferior thyroid artery may or may not be exposed and divided. Both arteries are generally severed, however, to obtain

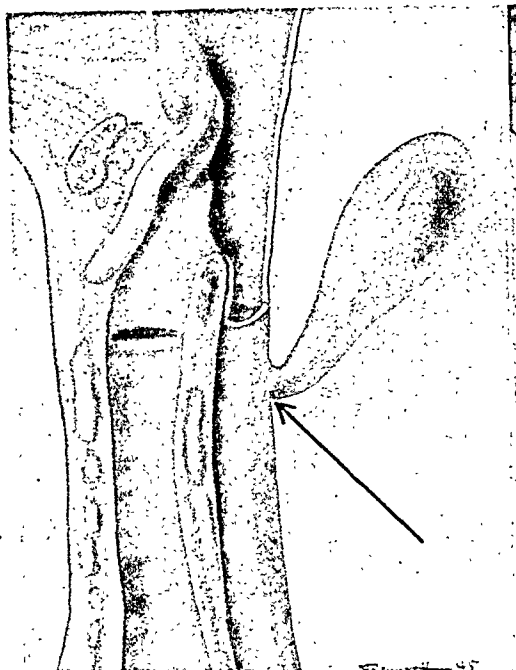


FIG. 3. Proper dissection.

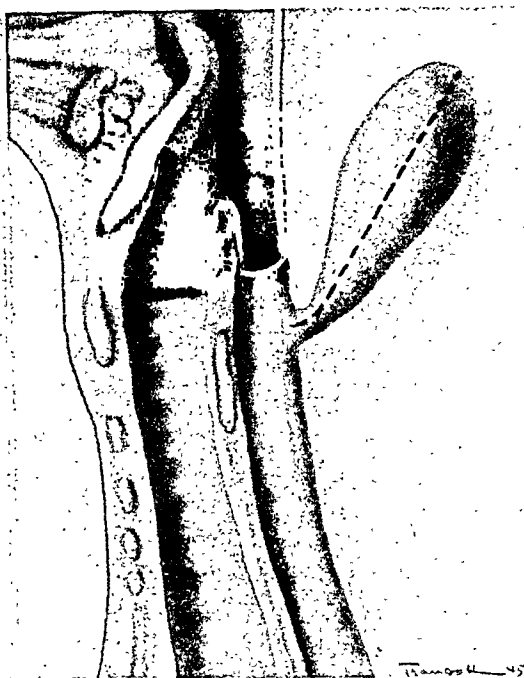


FIG. 4. Sac cut along its long axis.

The skin incision is usually made along the anterior border of the left sternocleidomastoid from the superior border of the thyroid cartilage to the suprasternal notch. The deep cervical fascia is opened by dividing it along the anterior border of the sternomastoid muscle, and the latter dissected from its fascial sheath and retracted laterally. The ribbon muscles (omohyoid, sternohyoid and sternothyroid) on the thyroid are dissected free and retracted medially. The superior belly of the omohyoid is detached from its insertion on the hyoid bone and is either freed or resected down to its tendon. The ribbon muscles must be divided in some cases to secure better exposure. There is always severe bleeding in severing the attachment of the omohyoid to the hyoid bone. This is, however, easily controlled. The ribbon muscles are grasped with the forceps and retracted medially exposing the thyroid gland. The branches of the superior thyroid artery are exposed, ligated, and divided.

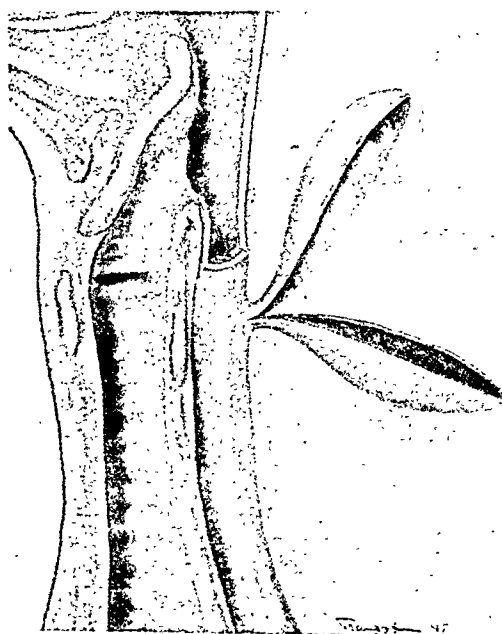


FIG. 5. Result—dog-ear flap.

better exposure of the esophagus which lies medial to these vessels. It is usually also necessary to divide the middle thyroid veins.

The dissection is carefully carried along the lateral aspect of the thyroid gland retracting and rotating the larynx toward

is turned superiorly and attached to the fascia of the ribbon muscles of the neck in such a manner that the sac drains



FIG. 6. Lateral view of a large diverticulum.

the opposite side while retracting the carotid and jugular vessels toward the lateral aspect of the wound. Good retraction and free exposure are especially helpful in the operative procedure.

The diverticulum is now exposed and is carefully dissected up to the neck of the pouch at its attachment to the esophagus. It is essential that the muscle fibers of the inferior constrictor at the neck of the sac be severed. During this exposure severe hemorrhage which is easily checked may occur. One must proceed with caution while separating the pouch from the esophagus toward its neck because there is danger of perforation of the esophagus at the junction of the neck of the pouch with the esophagus. If perforation occurs, suppurative mediastinitis will result and probably death. (Figs. 1, 2 and 3.)

When the pouch has been completely freed and properly separated the fundus



FIG. 7. Lateral view ten days postoperatively, showing fundus turned superiorly and attached to the fascia of the ribbon muscles of the neck.

downward and readily empties itself. The patient now has no difficulty in swallowing and fluids can be immediately given postoperatively. It is of the utmost importance that only the fascia of the fundus be attached to the prethyroid muscles and that neither the suture nor the needle penetrate the sac itself; otherwise sepsis will result and probably death. In order to locate the pouch easily in the second stage it is well to leave several long silk sutures attached to the fascia of the fundus inasmuch as possible shrinking of the sac during the interim will make it difficult to find. A cigarette drain with gauge protruding is packed into the wound in such a manner that the superior mediastinum is walled off. The skin incision is closed and the second stage is performed within eight to ten days.

Eight to ten days later depending upon the patient's condition the second stage is conducted. The neck is opened and the sac exposed as described for the first stage. A dog-ear flap is made by cutting the sac along its long axis. (Figs. 4 and 5.) The two flaps of the sac are cut off at its junction with the esophagus. The opening into the esophagus is roughly closed by either continuous or interrupted gut sutures. Rough closure is good enough since leakage will occur regardless of the method used

for closure. The leakage is insignificant at this time since the superior mediastinum and cervical tissues have been walled off by packing in the previous operation. A cigarette drain placed in the wound is left for seven or eight days. A Levine tube inserted through the nose to the stomach is used for feeding. (Figs. 6 and 7.)

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THE presence of adenoids may be inferred by the characteristic facies and proved by palpation. Chronically infected adenoids should be removed, and their removal comes within the scope of minor surgery.

From "Minor Surgery" edited by Humphry Rolleston and Alan Moncrieff (Philosophical Library).

# MODIFICATIONS OF THE TROCAR METHOD WITH POSITIVE PRESSURE FOR INSTILLING AMNIOTIC FLUID CONCENTRATE INTRA-ABDOMINALLY AT THE CLOSE OF OPERATIONS

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CERTAIN modifications of the technic for instilling amniotic fluid concentrate intra-abdominally at the close of operations previously described<sup>1</sup> seem expedient for the purposes of providing an apparatus which will have the maximum durability and flexibility of operation, and at the same time, facilitating the instillation more efficiently and quickly of the fluid in as large a quantity (up to a 1,000 cc.) as is desirable. The full assembly of this apparatus consists of:

1. A 90 cc. metal syringe with a Luer-Lok attachment at the tip of the outlet.

2. A two-way metal valve which is essentially the same as described<sup>1</sup> except that the male part of the valve has been adapted into a tubular metal extension. This extension is 3.1 cm. long and is securely fastened to the valve, but removable. (Fig. 1.)

3. A solid rubber stopper, size 7, height 2 cm., and 55 Shore hardness. The stopper has a depression on its superior aspect sufficient to seat the body of the valve snugly, as well as a vertical groove allowing the close approximation of that part of the valve which is attached to the tubular metal extension.

4. A pure gum rubber sleeve serum stopple; stopple 2.5 cm. in diameter and 25 Shore hardness. The stopple has an eccentrically placed opening which is 1 cm. from its circumference and 0.8 cm. in diameter.

5. A one liter Pyrex aspirator flask.

6. A pure gum rubber tubing 31 cm. in length, with a diameter of 2 cm. and a wall of 0.4 cm. thickness.

7. A Hoffman cut-off, 2.8 by 2.1 cm.

8. A Vitax reducing connecting tube, 1.3 to .6 cm., 7.8 cm. in length.

9. A pure gum rubber tube 112 cm. long, 0.8 cm. diameter, 0.2 wall thickness.

10. A trocar which is the same as to length, diameter, and series of openings as previously described.<sup>1</sup> The stylet is unchanged. Changes in the construction of the trocar consist of fixation of a flat piece of metal as an integral part of the trocar. This addition, is 3.7 by 2.3 by 0.1 cm. with its four corners slightly rounded. It is fixed 2 cm. from the proximal end of the trocar, so that the center of the flat piece of the metal's longest diameter is at right angles to the shaft of the trocar. At the distal end of the trocar, each alternate opening in the series of openings has been enlarged. Thus there are thirty openings 0.2 cm. and a like number 0.1 cm. in diameter. (Fig. 2.)

11. A stainless steel five liter solution bowl.

12. A stainless steel 14.5 cm. funnel.

13. A 220°F. laboratory thermometer, 30 cm. in length. (Fig. 3.)

14. Sterile long fiber cotton.

15. Sterile gauze. The entire assembly is placed upon a table under the customary conditions of asepsis.

The following procedure is used when amniotic fluid concentrate is used from rubber stoppered glass containers: (1) Clean off label and outside of bottle without wetting the gelatin-like covered stopper. (2) Dip top of bottle and entire neck of the bottle into an antiseptic solution composed of:

Trikresol

Carbon tetrachloride

Benzol

Acetone

Isopropyl alcohol, 99% aa 150.00

(3) Wipe top and neck of bottle with sterile gauze. (4) Remove gelatin-like cover of stopper with a forcep. However,

The use of glass stemmed containers for the amniotic fluid concentrate, thus eliminating the use of rubber stoppers.

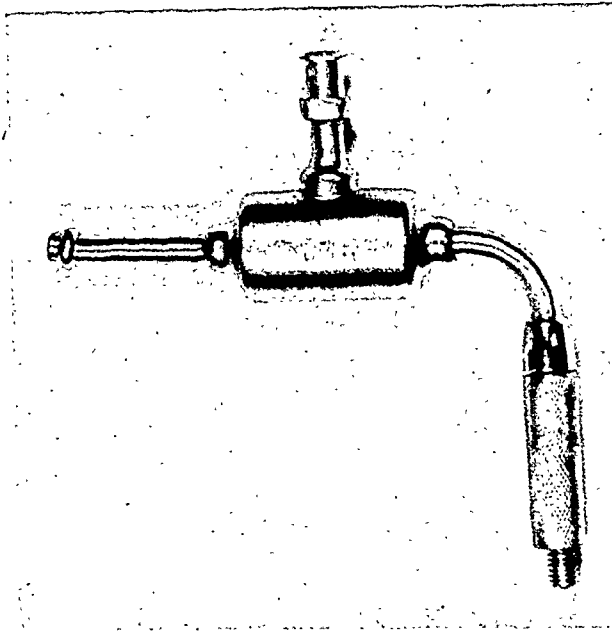


FIG. 1. Photograph of two-way valve with extension.

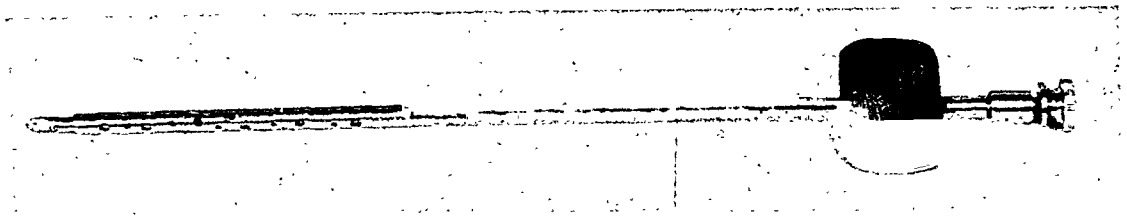


FIG. 2. Photograph of trocar with stylet.

gelatin-like cover may be removed before step 2, and, when this is done, step 4, 5 and 6 may be eliminated. (5) Dip top and neck of the bottle into the antiseptic solution again. (6) Wipe stopper and neck of bottle with sterile gauze to remove antiseptic. (7) Remove rubber stopper. (8) Wipe inside of neck of container where rubber stopper had been fastened with a gauze wick, slightly moistened with the above antiseptic. Wipe with an upward and outward motion so as not to push any particles possibly present into container's solution. (9) Wipe inside of neck of the bottle with a dry gauze until thoroughly dry. (10) Wipe top and neck of bottle with dry gauze until dry.

would remove some of the above precautionary measures. The steel funnel which is fitted with a piece of long fiber cotton, sufficiently large, and so placed as to act as a filter, but not as a tightly fitting plug, is inserted into the mouth of the Pyrex aspirator flask. The flask's outlet at the base is adapted into the large sized rubber tubing (2 by 31 cm.), and the Hoffman cut-off is closed securely with the right hand aided by the compression of the rubber tube by the thumb, first and second fingers of the left hand, about 12 cm. from the flask. Now the desired amount of the aqueous solution of the amniotic fluid concentrate is filtered through the funnel into the aspirator flask. When this is done, the



fluid is ready to be warmed to the desired temperature which is slightly above that of the normal body. This is done by placing

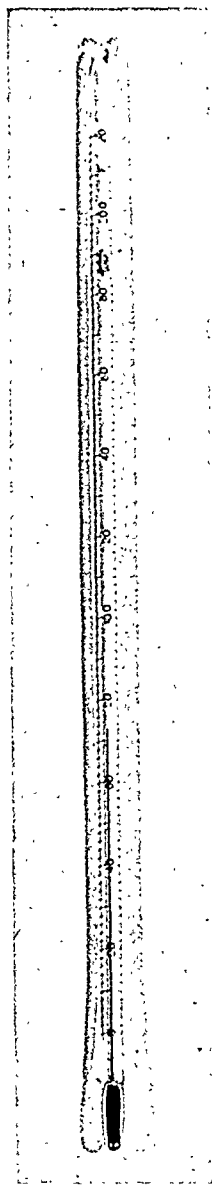


FIG. 3. Photograph of thermometer.

the Pyrex aspirator flask containing fluid in the center of the solution bowl and pouring hot water around the flask. This must be done at such a distance from the patient so there is never any possibility of spilling hot water on him. The sterilized thermometer (Fig. 3) is inserted into the mouth of the flask to the bottom of the

contained solution. The temperature of the fluid will rise very rapidly to the desired temperature, slightly above normal. The thermometer is withdrawn and discarded. The flask with the attached rubber tubing is removed from the solution bowl and placed on the instrument table so that the aspirator flask's outlet faces the patient's head and is parallel to the axis of the body.

The large end of the Vitax reducing connecting tube is adapted into the distal opening of the rubber tubing attached to the outlet of the aspirator flask and the other end is adapted into one opening of the rubber tubing 0.8 by 112 cm. The proximal end of the trocar is adapted into the free end of the latter rubber tube. The method of inserting the trocar with its dull stylet into the abdominal cavity has been described elsewhere<sup>1</sup> and the procedure is the same except that care should be taken that the small incision made in the anterior abdominal wall should follow as closely as possible the rule of making an incision in the same general direction as the muscle, nerves, and vessels. The sutures for closure of the small opening are most conveniently placed in the muscles and skin, while the fingers of the left hand are still functioning as a guide from within the abdominal cavity at the time of the insertion of the trocar intra-abdominally. The sutures are left untied until later.

The tubular extension fastened to the two-way valve is adapted into the sleeve serum stopple, and the solid rubber stopper with its depressions is fitted appropriately and snugly between the body of the valve and the stopple. The stopple is adapted into the mouth of the aspirator bottle so that the horizontal free end of the two-way valve is directed opposite to the direction of the flask's outlet. The sleeve of the serum stopple is drawn down over the mouth of the flask. The vertical opening of the valve is readily adaptable into the Luer-Lok attachment of the tip of the 90 cc. metal syringe. (Fig. 4.)

The Hoffman cut-off is now opened completely. Positive pressure is exerted upon

the fluid in the flask by movement of the syringe's piston which by being withdrawn sucks air into the syringe. Compression by (or 1:2000 in patients weighing over 60 kg.) is similar to that advised for usage by Boehme.<sup>2</sup>

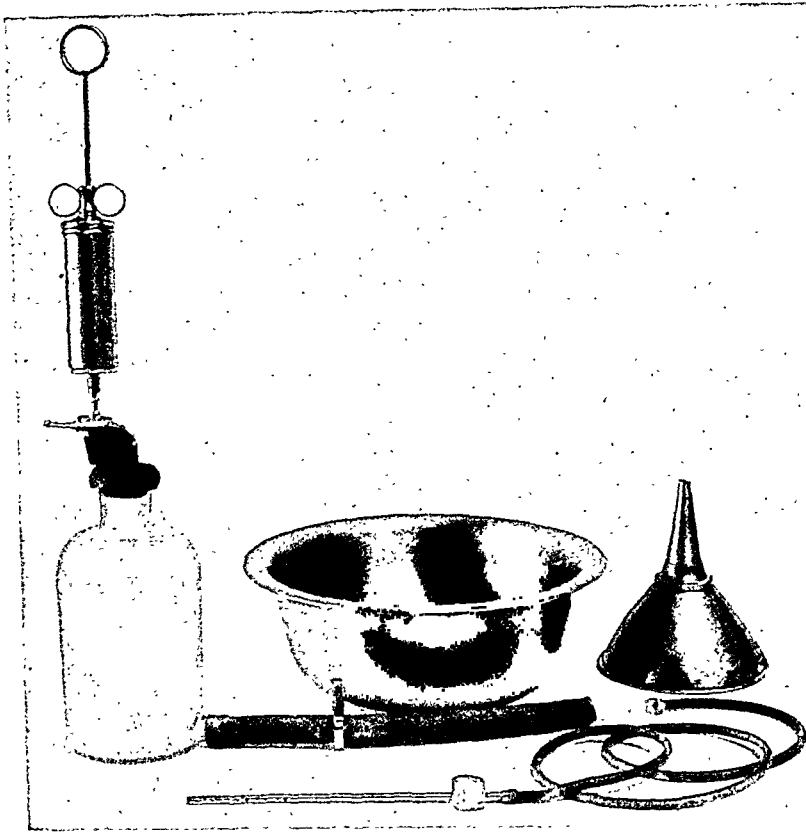


FIG. 4. Photograph of apparatus arrangement for instillation of fluid and solution bowl and funnel.

downward pressure forces the air into the Pyrex flask forcing the fluid out of the outlet into the tube and trocar into the abdominal cavity. In this way, the desired quantity of amniotic fluid concentrate up to 1,000 cc. can be instilled quickly intra-abdominally. When the flask appears empty, the sleeve serum stopple and valve are removed from the flask's mouth and the flask is elevated a short distance from the instrument table draining any possibly remaining drops of solution in the tube, etc., into the trocar. The trocar is then removed from the abdomen, and the previously inserted sutures are tied closing the small incision.

Prostigmin is given subcutaneously as soon as the fluid has been instilled. The dosage of prostigmin in ampules 1:4000

#### COMMENTS

The above are modifications of a similar method previously described<sup>1</sup> to provide a more uniform distribution of amniotic fluid concentrate within the abdomen and reduce the possibilities of its escape when closing the peritoneum. The changed technic differs in that it allows the elimination of a 100 cc. glass syringe, a glass Kelly jar with supporting stand, and a glass funnel. The improved type trocar (Fig. 1) facilitates manipulation of that instrument by the left thumb, and first and second fingers. The metal two-way valve is no longer adapted into the trocar's proximal end. This affords greater flexibility. The amniotic fluid concentrate is not sucked into a syringe via tube from the Kelly jar, and, then pushed through the trocar.

This saves time and work. Also, there is less opportunity for the aqueous solution of amniotic fluid concentrate to lose temperature by cooling. Less assistance is necessary, because, as soon as the trocar has been inserted, and, the peritoneum of the primary abdominal incision closed, one operator may perform the necessary steps unaided to the completion of the fluid's intra-abdominal instillation, while, simultaneously, others may proceed with the closure of the abdominal wound.

Adams<sup>3</sup> wrote in 1913 that stimulation of peristalsis to prevent adhesion was important, and the rapidity of peristalsis must be considered to militate against the formation of adhesions. This opinion has been expressed repeatedly. On the continent, Payr<sup>4</sup> urged the early postoperative stimulation of intestinal peristalsis, and said that the more independent motion that an abdominal organ had, the more it is protected against tenacious adhesions, and the quicker it will free itself from such conditions. Prima<sup>5</sup> substantiated the necessity for increasing peristalsis to prevent adhesion formation.

Opinions differ as to the manner in which peristalsis should be stimulated, postoperatively. Some, especially European surgeons, have advocated early feeding in the postoperative management of patients; but experience seems to show that the best postoperative care, in general, where there has been abdominal surgery, should include the withholding of food by mouth for several days at least, and, as Boehme<sup>2</sup> stated recently, the restriction of oral intake of fluids for twenty-four to thirty-six hours.

An effective means in common use of stimulating peristalsis is by use of such drugs as prostigmin and pitressin. Prostigmin is employed for this purpose as described above when amniotic fluid is instilled, and also by constantly changing surfaces, to gain the best possible early distribution of the isotonic aqueous solution of amniotic fluid concentrate, that it may function as previously discussed.<sup>1</sup>

Payr<sup>4</sup> said that if the wounded surfaces of serosa lying one on another are unable to free themselves in due time, a firm peritoneal soldering becomes a fixed fact for the time being. Prostigmin is given at four-hour intervals for at least three doses. Then, if no contraindication exists, pitressin, in about half the standard dose is used instead at desired intervals. The fluid requirements of the patient are maintained by parenteral administration *pro rata nata*. The importance of maintaining a normal electrolyte and fluid balance as a necessary adjunct to management of patients postoperatively is well known, as expressed by Muntwyler and Mautz.<sup>6</sup> Fuge and Hogg<sup>7</sup> have emphasized the recognition of the clinical importance of insensible loss in order that replacement be made according to the physiological requirements of the surgical patient. The opinions of Cutting et al.<sup>8</sup> as to the physiologic responses of the body to direct artificial addition of solutions of inorganic substances to the circulation, deserve consideration.

McIntyre<sup>9</sup> states that, although more than a thousand experimenters have conducted a search during the last half century for the mechanism of shock, they have failed to find any single cause capable of initiating the complex train of events seen in all cases of shock. It is not surprising that opinions differ not only as to possible causes but also as to forms of treatment to be used. Amniotic fluid concentrate when given in quantities as much as 1,000 cc. into the abdominal cavity at the close of operation, not only adds fluid to the patient before he leaves the operating room, a measure similar to that reported by Moon<sup>10</sup> as used for reducing the occurrence of shock following operation, but also because of its healing effect on traumatized peritoneal tissue, amniotic fluid concentrate must be considered beneficial in the treatment to prevent shock. Johnson<sup>11</sup> following his observations on the anesthetic and fibrin organizing effect of amniotic fluid concentrate, concluded that it might be valuable in neutralizing

the effect of traumatic stimulation of the splanchnic nerve endings in paralytic ileus. He suggested the use of large quantities of fluid after extensive surgical procedures in the abdomen. It is desirable, on the basis of anatomical and physiological facts, to use as large quantities of amniotic fluid concentrate as possible when its use is indicated. The peritoneum may be regarded, according to Jackson,<sup>12</sup> as a closed sac, the inner surface of which is smooth while the outer surface is rough and is attached to the tissues which surround it. In the male subject, the peritoneum forms actually a closed sac; but in the female its wall exhibits two minute apertures at the openings of the Fallopian tubes. Miller<sup>13</sup> states that the peritoneum secretes a slight amount of clear fluid which acts as a lubricant and so permits the viscera to move freely over one another without friction. Lewis<sup>14</sup> says the peritoneum is the largest serous membrane in the body, and Deaver<sup>15</sup> asserts its area with its reflexions and folds is almost equal to that of the integument of the body, and Massie<sup>16</sup> and Horsley<sup>17</sup> concur in this. The chief characteristic of the peritoneum writes Deaver<sup>15</sup> is its absorptive power which allows a quantity of fluid to be absorbed equal to the body weight within twelve to thirty hours. Hertzler,<sup>18</sup> while admitting that astonishing individual variations are encountered without there being apparent reasons, stresses the rapidity of the rate of peritoneal fluid absorption by the peritoneum. Also, Hertzler<sup>19</sup> gives the opinion that in the case of isotonic solutions, the absorption rate is the same for several half-hour periods. Piersol<sup>20</sup> cites Wegner as reporting that 3 to 8 per cent of the body weight in fluid can be taken up by the peritoneum from within its cavity in an hour which is equivalent to the total body weight in twenty-four hours. Thus, authorities are in agreement substantially as to the absorptive power of the peritoneum. These facts emphasize the necessity for the use of large quantities when using amniotic fluid concentrate.

Payr<sup>4</sup> believed the damage to the peritoneal serosa by the trauma of aseptic laparotomy was considerably more important than was generally supposed. He quoted Seifert that drawing the greater omentum forth from the peritoneal cavity for a few minutes, or touching of the peritoneal surface by a dry or wet compress produces an accumulation and migration of white blood cells and exudation of fibrin. In addition, slight chemical or thermal influences cause swelling and loosening of the surface cells, frequently, with nuclear degeneration and necrosis. Hertzler<sup>19</sup> adequately described the process by which the agglutination of the injured peritoneal surfaces takes place.

Prima<sup>21</sup> declared that hardly any other factor damages the peritoneal epithelium so much as the dehydration of the tissue, and that the drying of the peritoneum favors adhesion formation. To combat the effects of dehydration he employed irrigations of warm physiological saline solutions in the abdominal cavity postoperatively. Amniotic fluid concentrate used in as large a quantity as a 1,000 cc. when possible offers an effective means of overcoming the effects of dehydration of the peritoneal surfaces at the close of operation.

Piersol<sup>20</sup> said the resistance of the peritoneum to infection is usually in direct proportion to the normality of its mesothelial coat which is lessened by any form of traumatism including handling, or sponging or irrigation with strong antiseptics.

A certain amount of trauma to tissues in the abdominal cavity is inevitable when they are subjected to surgical procedures. In surgery in the abdomen, when conditions permit, routine examination of the abdominal tissues has long been recognized as necessary; in fact it is often the only means of appraising the pathological condition present. This involves handling of peritoneal surfaces. Adams's<sup>3</sup> quotation of Grawitz's definition that peritoneal adhesions are the product of "reaction of the irritated and damaged tissues which still retain their vitality" requires considera-

tion. The importance of infection in the formation of adhesions has long been recognized. Adams<sup>3</sup> wrote that the presence of unsuspecting organisms accounted for many of the misfortunes of abdominal surgery, and their relation to the formation of peritoneal adhesions was a question which he thought received too little attention. He said the bactericidal power of the intact peritoneum was undeniable and yet a comparatively slight infection may be enough to ruin the perfect smoothness of the endothelial continuity, and that it is common to speak of "protective" adhesions which wall off infected areas of the peritoneum from the general cavity, but, unfortunately, these may eventually lead to intestinal obstruction and prove disastrous rather than beneficial. Other surgeons, such as McIver,<sup>22</sup> list inflammatory reactions in the peritoneal cavity as responsible directly and indirectly for a large group of intestinal obstructions. He said the bands, adhesions, inflammatory lymph glands, etc., that arise from inflammatory reaction in the peritoneal cavity are the result not only of bacterial inflammation of the peritoneum but also of mechanical injury, usually incidental to abdominal operations. And that the forty years, prior to his publication, that had marked the rise of abdominal surgery, intestinal obstructions following laparotomies had formed an increasingly large proportion of the total cases.

Haug<sup>23</sup> discussed the prevalence of abdominal adhesions after laparotomy on the basis of clinical statistics gathered from relaparotomized patients, and stressed the importance of the necessity of using every possible measure to prevent adhesion formation following abdominal surgery.

At Yale, Ives and Hirshfeld<sup>24</sup> demonstrated, by extensive studies on the bacteriology of surgical wounds made with due regard to all principles of aseptic surgical technic, that extensive contamination with bacteria existed.

Muller and Rademaker<sup>25</sup> state that adhesions after laparotomy frequently give

rise to more acute symptoms than the condition for which the operation was done, and that adhesions are primarily formed by trauma on which irritation by chemicals or bacteria is superimposed. They conclude as a result of animal experimentation that infection is the primary etiologic factor in the production of postoperative adhesions. However, it must be admitted that animal experimentation, in regard to adhesion formation, cannot be considered entirely satisfactory because of certain essential differences between 'man and lower animals. An important difference, as stated by Jackson,<sup>12</sup> is that the marked changes associated with extensive secondary adhesions of the primitive peritoneal structures are found only among the higher mammals, especially in man and the anthropoids, associated with the assumption of erect posture.

Even if there is some variation in opinion, as discussed above, as to the relative importance of some of the known factors causing adhesions, amniotic fluid concentrate has great importance when instilled intra-abdominally at the close of operation, as an effective agent which minimizes the formation of postoperative adhesions in a traumatized peritoneum by producing a reaction stimulating the normal processes of repair; and in the presence of abdominal bacterial contamination, it will stimulate the normal defense repair mechanism to the end that the incidence of postoperative infection will be markedly decreased and early resolution accelerated. As regards the latter, is a well known fact cited by Steinberg,<sup>26</sup> that when bacteria invade the peritoneal cavity, there is an initial lag of multiplication during which the microorganisms adapt themselves to the new environment. This lag varies from a few to twenty-hours depending on the environmental conditions. The great importance of attempting to exploit the advantage of this lag period for the good of the patient by the use of amniotic fluid concentrate at the close of operation is obvious

Steinberg<sup>26</sup> enumerates other causes for intraperitoneal adhesions. It is not the purpose to discuss further the known causes here, or those causes which in the light of present knowledge are intangible of definite explanation. That the capacity to form adhesions varies greatly in different individuals has long been universally recognized. The inherent tendency for certain patients to form massive tenacious adhesions causing serious postoperative complications has been the subject of extensive consideration by many surgeons, such as Payr<sup>4</sup> and Haug.<sup>23</sup> Maguire and Scott-Orr<sup>27</sup> rightly state that adhesions may form anywhere in the abdomen apparently without adequate cause, it is recognized that injured surfaces are more likely to adhere, and reperitonealization has been the sheet anchor of the modern surgeon. That the use of amniotic fluid concentrate in the abdomen at the close of operation is of great importance in the prevention of the formation of adhesions, the experiences demonstrated in previous published reports verify, but it is definitely not to be regarded as a panacea for the prevention of all possible postoperative adhesions, because many factors active in the production of these adhesions in the abdomen are insufficiently understood or are as yet beyond practical control. A consideration of the latter is essential for a necessary and proper recognition that the prevention of adhesion formation cannot be expected in every case by the use of amniotic fluid concentrate alone. In each case, the aid of medicinal measures for the solving of the problems of adhesion formation prevention in abdominal surgery includes, as paramount, a constant appreciation of the aid possible through the facilities of internal medicine. The use of amniotic fluid concentrate in the abdomen must be considered as the employment of an effective powerful agent for the prevention of adhesion formation for the reason that Adams<sup>3</sup> expressed long ago when he spoke of peritoneal adhesions, and said that an endeavor at prevention of adhesions is

better than an endeavor to cure them when present; prevention is not only better, but easier.

Bainbridge<sup>28</sup> recently called attention to the formation of adventitious bands as one of the delayed or slow developments in the abdomen, occurring as a result of trauma to the abdominal viscera from the action of an impact or force acting externally to the abdominal wall. With the passage of time the effects seem unrelated to the injury itself. Since in civilian life opportunity for such types of trauma is not only frequent but apparently on the increase, a consideration of this subject is necessary for the proper evaluation of the cause of adhesion formation and the complications thereof when occurring in patients who have had abdominal surgery at some time in their lives.

Amniotic fluid concentrate has been used successfully in the treatment of some types of peritonitis, but it must be emphasized that the fluid should not be used in the peritoneal cavity in the presence of pus. The surgical experience of the past with other solutions, viz, normal saline, etc., will explain why the use of amniotic fluid concentrate in the presence of pus in the peritoneal cavity is contraindicated.

The late A. J. Ochsner,<sup>29</sup> a pioneer in the treatment of inflammations of the abdomen, said that when during the development of a spreading general peritonitis, following, e.g., the perforation of an appendix or a gastric or duodenal ulcer, there is an acute inflammatory condition of the serosa set up by the irritation of highly toxic material in the abdominal cavity, accompanied by a free exudation of serum and migration of leucocytes into the cavity, and the development of pus, all the flow is from the vessels into the abdominal cavity, and comparatively little of the toxic material is absorbed into the blood. If this were not so, cases of general peritonitis would be far more rapidly fatal. But when the abdomen, containing a considerable quantity of septic pus, is freely irrigated by normal saline, a certain

quantity is always left behind; this fluid, which is highly toxic is rapidly absorbed into the circulation. It is well known that large quantities of normal saline, when introduced in the abdomen, are very rapidly absorbed. The current, instead of being from the blood into the peritoneal cavity, is from the cavity into the blood stream and the patient dies of toxemia.

In the light of A. J. Ochsner's<sup>29</sup> explanation, Schonbauer's<sup>30</sup> publication of successes and failures observed in Eiselberg's clinic is important and illustrative of what occurred when a pepsin hydrochloric acid solution was used in irrigation of the peritoneal cavity. The observations were carried out for three and a quarter years in a large series of cases of perforation peritonitis. Due to the abundant material available in the large clinic, opportunity for an authoritative estimation was plentiful. Quantities of  $1\frac{1}{2}$  to 3 liters of solution were used for irrigation in the abdominal cavity. Some of the solution remained following irrigation. The mortality rates, in general, when the solution was used in certain types of perforation peritonitis showed a marked reduction as compared to those of previous experience with other methods. However, in the failures, the late cases, in which a time interval had been long enough for progressive inflammatory changes of a septic nature to become established, the instructive case reports indicated the dire pathological consequences of a vicious fulminating toxemia. Schonbauer<sup>30</sup> pleaded for earlier surgical intervention as the only means by which the mortality rate could be favorably influenced saying any therapy is too late when the internal organs exhibited serious changes.

Hence when an aqueous solution of amniotic fluid concentrate is used in the peritoneal cavity in the presence of pus, an unsuccessful result is to be expected. According to Murray,<sup>31</sup> the use of amniotic fluid concentrate was of no avail in treatment of a case of massive seropurulent peritonitis. Gepfert's<sup>32</sup> experience in the

use of amniotic fluid concentrate in human peritoneal cavity in the presence of pus substantiates the above opinion, and he states that it should not be used at the time of operation if the presence of pus is suspected.

In certain occasional cases, as in a massive postoperative ventral hernia of long standing, the above described technic of instillation and the use of large quantities of amniotic fluid concentrate is not desirable as a routine procedure, if the tissues of the abdominal wall show such extensive pathological changes that they are difficult to identify, and the thinned, torn peritoneum can only be closed with the greatest difficulty.

In such cases, when the peritoneum is closed, and to avoid the possibility of causing any pressure against the anterior portion of the abdominal wall, the use of a smaller quantity, e.g., 100 cc. may seem indicated. This is conveniently injected by using an ordinary 50 to 100 cc. glass syringe and a No. 19 gauge needle. The desired quantity of amniotic fluid concentrate is injected into the cavity carefully, through the lateral anterior peritoneal wall or some place where the fluid can gravitate posteriorly to a dependent portion of abdominal cavity.

What Whitaker<sup>33</sup> said about a surgical procedure elsewhere, may be applied here: Reason should be followed in determining the manner and quantity of amniotic fluid concentrate used in the abdomen, not a rule or a fixed course of action.

#### SUMMARY AND CONCLUSIONS

Some changes are given here of a technic previously described for instilling amniotic fluid concentrate by the trocar method with positive pressure at the close of abdominal operations. The purposes for the improvements are to give the advantages of an apparatus which has more durability, and flexibility with more efficiency of action, and with greater economy of time and labor to the operator and assistants than before. Certain necessary precau-

tionary measures are explained and a method suggested for use when amniotic fluid concentrate is to be used from rubber-stoppered glass containers. Several reasons are given for the necessity of stimulation of intestinal peristalsis early, beginning in the operating room upon the completion of the instillation of the amniotic fluid concentrate.

The importance is stressed for the usual necessary care in the postoperative management of fluid requirements in each case.

Amniotic fluid concentrate as given at the close of operation is of great importance in its action in contributing to the proper management of postoperative water balance requirements, and in the prevention of the postoperative occurrence of shock, especially when employed in quantities up to 1,000 cc.

Authoritative opinions are given as to the large surface area of the abdominal peritoneum and its great power of absorption which shows why there is a definite need for the use of quantities of amniotic fluid concentrate up to 1,000 cc., when its employment is indicated at the close of operations in the abdomen, to best overcome the effects of dehydration. By stimulation of the defense-repair mechanism, its action is invaluable in the prevention of the bad results of peritoneal trauma and of bacterial contaminations leading to peritoneal infections and consequent complications thereof.

Amniotic fluid concentrate should be introduced into the abdomen at the close of operations as early as possible, close as possible to the time of earliest contamination and in the lag period as described above, when it can exert its greatest effectiveness on the peritoneal defense mechanism to the best possible advantage of the human organism.

Amniotic fluid concentrate cannot be expected to act as a panacea, because many factors, constitutional, etc., active in the causation of adhesion formation, cannot be controlled in every individual case. Amniotic fluid concentrate is contraindi-

cated in the presence of pus, because of physiological and pathological reactions, occurring under certain conditions peculiar to abdominal peritoneal tissues.

In occasional exceptional cases in which amniotic fluid concentrate instillation intra-abdominally is desirable at the close of operation the administration may be done more advantageously by another method rather than by the trocar method, and emphasis is placed on the fact that the surgeon should use that method which meets the conditions and indications of each individual case.

Amniotic fluid concentrate, when used as indicated by conditions in the abdomen at the close of operations, should be considered in the sense of an agent of insurance, a prophylaxis, a preventative of complications in abdominal surgery used for the purpose of insuring better results.

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# MODIFICATION OF RADICAL OPERATION FOR THE CURE OF INGROWN TOENAILS

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THE problem of treating ingrown toenails becomes very important when it is considered that the individual has about the desired cure, but it is attended by a long period of morbidity and disability ranging from sixteen days to six

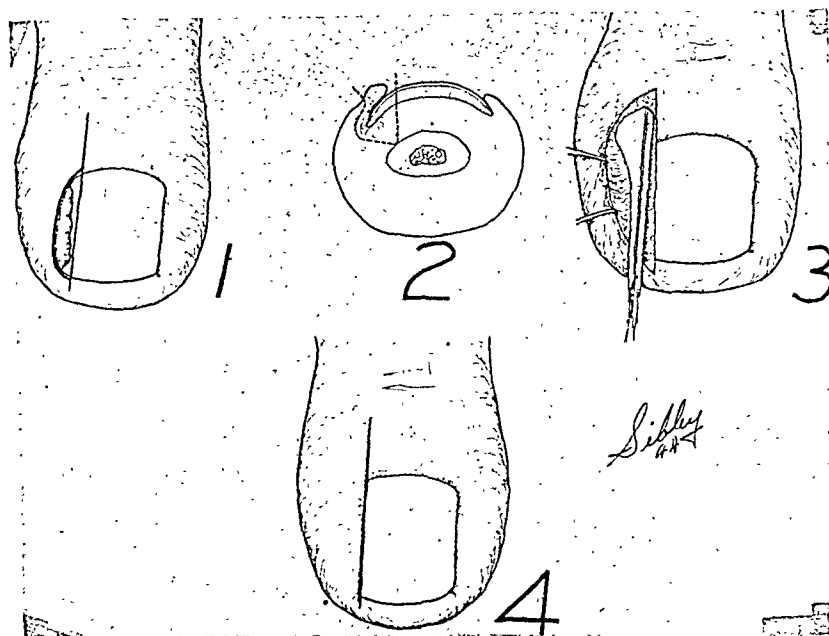


FIG. 1. Diagrams illustrating the technic of removing ingrown nail, matrix and nail bed. 1, incisions are made along lines indicated by heavy black lines. The curved lateral incision is just outside the diseased area of skin. 2, a cross section of the toe showing the wedge shape mass to be removed as indicated by broken lines. Only the diseased portion of skin is excised. 3, the diseased nail, matrix and nail bed are removed. The skin flap is retracted laterally. 4, the skin flap is pressed down in the wound leaving a clean linear scar.

ing such a condition may lose a considerable period of time from his occupation or duty if the condition is not treated properly. This is particularly true when the occupation or duty requires the individual to be on his feet for its performance. Temporizing palliative procedures will not effectively cure many of the cases of ingrown nails. Such temporizing procedures are prone to be followed by recurrences as soon as the nail grows out again. The standard radical operation<sup>1,2</sup> for ingrown nails which entails the cutting out of a wedge of nail, matrix and skin will bring

weeks or more before the wound is completely healed.<sup>2</sup> The operations of Bennett,<sup>3</sup> O'Donoghue,<sup>4</sup> and Winograd<sup>5</sup> all give good results. The O'Donoghue and Bennett operations, while they produce excellent results, require the use of sutures. Experience has shown that many times the sutures cut into the skin, prolong the morbidity and increase the healing time to a greater degree than when sutures are not used. (Fig. 9.)

It has been demonstrated at this station that sutures are not necessary for the accurate apposition of the skin flap to the

denuded area of the toe, and that healing takes place rapidly by primary intention. The apposition of the skin flap to the toe is

## TECHNIC

The foot and toe are surgically prepared with an antiseptic solution. Anesthesia is

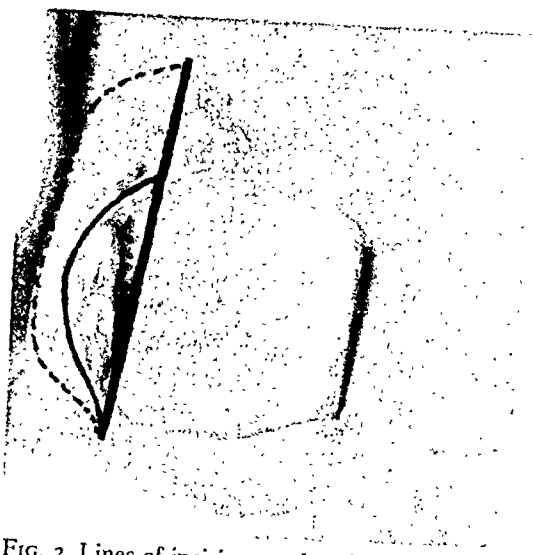


FIG. 2. Lines of incision employed in the radical treatment for ingrown toenails. Heavy solid lines indicate incisions. Broken line indicates undercutting necessary to form skin flap and remove diseased tissues.

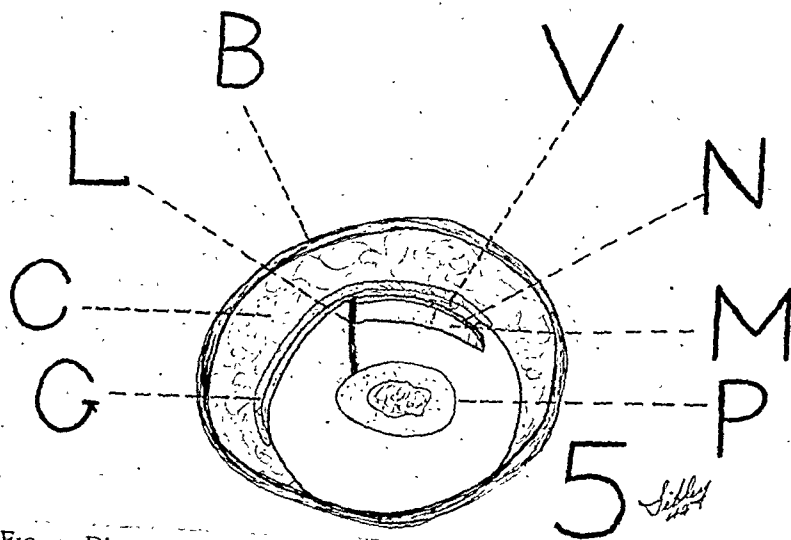


FIG. 3. Diagram illustrating method of maintaining closure of the wound (cross-section). G, one inch square gauze sponge; C, cotton for elastic pressure; L, line of incision; B, gauze bandage; V, vaseline gauze; N, nail; M, nail bed; P, distal phalanx.

maintained by snug-fitting padded pressure dressings. The technic used is essentially the same as that described by Bennett<sup>3</sup> without the use of sutures.

obtained by blocking the nerves at the base of the toe. A bloodless operative field is secured by applying a rubber band tourniquet around the proximal phalanx of the

toe. The lateral margin of the ingrown nail is excised with a longitudinal incision. (Figs. 1 and 2.) The incision extends into

the tip of the toe in line with the excised nail margin down to the bone. A skin flap is then formed by sharp dissection of the

FIG. 4.



FIG. 5.



FIG. 6.



FIG. 7.

FIG. 4. Photograph of ingrown nail before radical operation.

FIG. 5. Photograph of toe shown in Figure 4 taken five days after operation. Patient was able to wear regular shoe and return to full duty. The edema around the line of incision cleared up rapidly and only a trace of scar now remains.

FIG. 6. Photograph of ingrown toenail before radical operation. Notice the small areas of fungus infection.

FIG. 7. Photograph of the toe shown in Figure 6, taken five days after operation. The wound is healed. The regular shoe can be worn. The fungus infection responded rapidly to Castellani's carbolfuchsin solution applied locally.

the skin over the nail root. The liberated nail is easily removed with a straight hemostat. The matrix and nail bed are thus exposed. An incision is made through the matrix and nail bed from the root to

skin at the lateral margin of the nail bed. The matrix and nail bed are removed by cutting at right angles to the incision on top of the toe, removing the tissues in the shape of a wedge. (Fig. 1, No. 2.) This

leaves a clean, open, gutter-shaped wound with a skin flap at its lateral margin. (Fig. 1 No. 3.) A strip of vaseline gauze is placed over the wound and the skin flap is pressed

at which time the patient is in no further need of treatment.

Infected ingrown nails require some preliminary treatment to insure primary

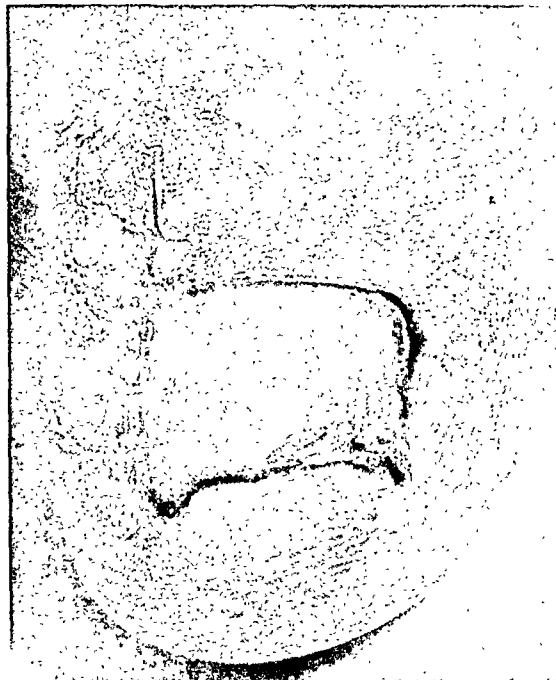


FIG. 8. Photograph taken on the sixth day after operation for ingrown nail. It reveals primary healing of wound. It illustrates the presence of a fungus infection which cleared up quickly with Castellani's carbolfuchsin solution. The patient was wearing regular shoe on this date.

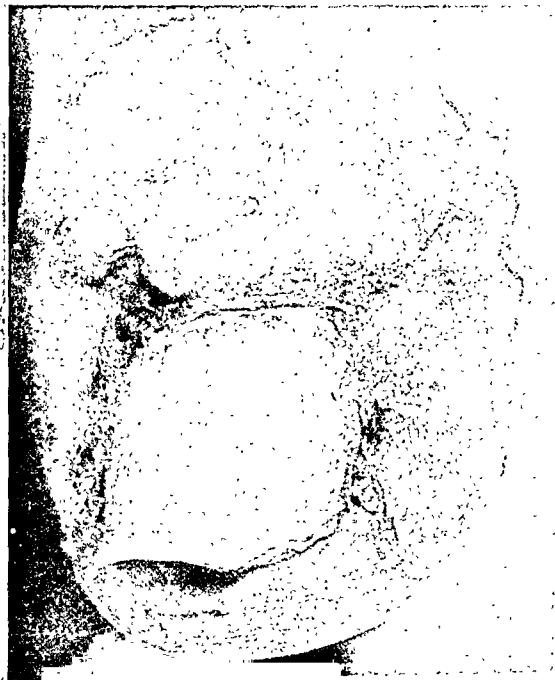


FIG. 9. Photograph of a toe taken fourteen days after bilateral ingrown nails had been excised. Sutures were used in this case and even though removed on the sixth day, they had cut deeply into the flesh. Complete healing occurred on the eighteenth day. This photograph was included in this paper for comparison with those in which sutures were not used.

down against the toe as a graft. (Fig. 1 No. 4.) A bulky pressure dressing composed of cotton and gauze is then placed on the vaseline gauze and a circular bandage is applied around the toe. (Fig. 2, No. 5.) The bandage should be so applied that the tip of the toe can be seen and inspected at all times in order to determine the state of the circulation of the part. The bandage may be cut on the undersurface of the toe and loosened if the circulation appears to be altered by the pressure dressing.

#### SUMMARY

A modification of the operation described by Bennett is presented. It has been used quite successfully at this station. The regular shoe can be worn comfortably in from five to seven days after the operation,

union of the skin flap. Frequently, associated fungus infections require additional treatment. (Figs. 6, 7 and 8.)

Diagrammatic illustrations of the technic employed are presented with photographs showing end results. (Figs. 4, 5, 6, 7 and 8.)

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# WHAT WAS WRONG WITH WHITEHEAD'S WORK?

## AN APPRAISAL OF HIS RECTAL OPERATION

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WALTER WHITEHEAD,\* a surgeon of Manchester, England, said on November 15, 1882, "During the past five years I have been excising hemorrhoidal tumors according to a plan which I believe to be more in harmony with surgical principles than the operations in general use, and I have abandoned those pyrotechnic aids and cumbersome appliances, etc." He goes on to relate the method which he has used in the surgical treatment of more than three hundred fifty cases of severe, massive, hemorrhoidal prolapse which he designates as "the cases where the blood equilibrium is destroyed and can no longer be cared for by the physician." After stressing pre- and postoperative care, he describes the amputative operation whereby the entire hemorrhoidal mass is freely and completely dissected to the "upper limit of the hemorrhoids," after which the cut edge of the overlying mucosa is sutured to the "denuded verge."<sup>1</sup>

Probably no article in medical literature has caused more discussion, or more misunderstanding, or has received more abusive epithets than what is commonly supposed to be the explanation of the "Whitehead Operation." The fact that this torrent of invective has flowed steadily for three-quarters of a century and shows no sign of abating makes one wonder whether, after all, there wasn't something good about it. Where there are clouds of besmirching smoke there must be some brilliant fire.

Indeed, no one can deny that White-

head's theory was good. The reasonableness of the idea was proved by the fact that his colleagues and followers tried repeatedly to follow his supposed plan. Some succeeded, more failed; but among those that succeeded are men who are considered to be pre-eminent today. We might consider the statement of Dr. Frank Yeomans which shows no enthusiasm for the operation, but which admits that: "Since, by this method (Whitehead method) the entire cuff of hemorrhoidal mucosa is removed, it appeals strongly to the surgeon on theoretical grounds, not only as radical, but as the operation of choice."<sup>2</sup>

In addition to the manifest sincerity of purpose and the logic of the plan, there is one point that is probably overlooked by many of the present generation: the "personal equation." It seems that in the old days when they lacked many of our modern advantages of diagnostic and therapeutic aids, personal skill loomed larger as a requisite than it does today. When men could not look through a fluoroscope at lung or stomach, they had to compensate by developing and refining their sense of touch and hearing. It is quite likely that they could listen better with their stethoscopes than we can because they had no other aids. And it is also quite likely that surgeons of those days, including Walter Whitehead, attained great manual dexterity and surgical judgment. The mere fact that Mr. Whitehead excised 139 cancerous tongues with reduced mortality, should vouchsafe his integrity and testify to his skill.<sup>3</sup>

Indeed, it seems quite plausible that this great surgeon was quite sincere and

\* Walter Whitehead, F.R.C.S., Ed.; F.R.S. Edin.; Surgeon to the Manchester Royal Infirmary, England; Past President of the British Medical Association; Professor of Clinical Surgery, Victoria University, England.

truthful in his report of 350 cures by his amputative method for advanced hemorrhoids.<sup>1</sup> There is undoubted truth in the opinion of one author who states:

"I think that Whitehead's favorable report is probably attributable to the fact that he did not perform the operation as it is popularly done today. He probably did the operation correctly. Those who attempt to do it according to his description very likely do it incorrectly."<sup>4</sup>

Thus, a new complexion is given to the matter. There is doubt about the description of the so-called "Whitehead operation." The man's integrity should carry some weight; the principles of the operation are in accord with the cardinal principles of surgery; his surgical skill was great. And now, in addition we have something else to think about.

Whitehead performed his operation correctly and obtained uniformly good results; others misinterpreted his description and got failures. Disgust, censure, and invective followed, the ultimate in abuse being voiced by one who attained some notice and some acclaim by coining the term, "Whitehead deformity."

Now why should the failure to attain Whitehead's success be attributed to misinterpretation of Whitehead's directions? Again let me quote from an authority representing an institution that has handled more than 30,000 rectal cases:

"It should be said, in justice to Whitehead, that the very prevalent ectropion of rectal mucosa seen following his operation is due to no fault of his. Had his instructions been understood and followed properly, no such deformity would have developed. For he explicitly stated that after the amputation has been completed, the mucous membrane of the rectum was sutured to 'the free skin margin' which remained after the circular incision had been made at the mucocutaneous juncture. The trouble has arisen as a result of a faulty conception of anorectal anatomy and instead of making the circular incision at the beginning of the operation, at the

pectinate line (mucocutaneous junction) the tissues have been cut in a circular manner at or near the anal verge and when the mucosa of the rectum has been sutured to this margin, it has become exposed externally."

In his thorough, conscientious manner, this authority goes on to elaborate why the confusion has arisen:

"Another expression which is often used synonymously with the term pectinate line is Hilton's 'white line.' If Hilton's own statement is to be examined, it will be found that the line to which he referred is synonymous with the intersphincteric line instead and his description alone is sufficient to convince the reader that he was confused . . . ."<sup>5</sup>

If the reader has not already abandoned this article as a result of being confused by the discussion of confusion, he will be convinced of three things: First, that if modern proctologists cannot agree on terminology, what chance did Whitehead have of describing his procedure with precision? Second, the reader will see that there is a plethora of eupheneous, ambiguous, and often meaningless terms (mucocutaneous line, anorectal juncture, white line of Hilton, etc.) Third, he will suspect that the surgical anatomy of the anorectum is vague and wonder if there are really any true surgical landmarks upon which the surgeon can depend for orientation and guidance.

Now the story can be told. Now, we know where and how to find the proper level at which to amputate a prolapsing hemorrhoidal mass and subsequently establish closure. The "denuded verge" of Whitehead takes in too much territory, gives a leeway of interpretation that invites trouble. Whitehead's good results were due to his surgical skill and intuition because the true surgical landmarks that afforded the determination of the "line or level" in question were not revealed until fifty years after Whitehead's death. Our present knowledge of the true surgical land-

marks of anorectal musculature developed after 1936.

That was when Levy produced proof that the conjoined longitudinal muscle interwove with the divisions of the sphincter to form a web.<sup>6</sup> He started something. Prior to that the surgeon was laboring under the delusion that the sphincters were stacked in a vertical line like a stack of doughnuts, a concept as useless as it was false.

The "web concept," on the other hand, shows how, why, and where landmarks are formed and what forms them. And in addition, one can readily see how the branched tubular glands at the base of the anal crypts penetrate the meshes of the web to various depths and, according to their depth of penetration, produce a variety of clinical manifestations. This is to say that when the true arrangement of the anorectal musculature is visualized, most of the rectal surgeon's problems are automatically solved. He sees the mechanism of patholysis; he has precise orientation and guidance by tangible landmarks.

Furthermore, he sees where the "line or level" is to be established in the amputative operation for prolapsing hemorrhoids. "The 'level' should be established midway

between two easily palpated landmarks: the intermuscular groove and the puborectalis muscle which separates the rectal ampulla from the anal canal."<sup>7</sup>

Now, to answer the question as to what was wrong with Whitehead's work: The answer is that nothing was wrong with the work of Whitehead himself. The "wrong" was done to the name of this great surgeon by the less skillful ones who were unwilling to take the blame for their own mistakes or mishaps. There is no more justice in dubbing a recurrent inguinal hernia after repair a "Bassini deformity" than in calling the "ectropion of rectal mucosa" following an improper amputative hemorrhoidectomy a "Whitehead deformity."

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# Case Reports

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## BRODIE'S ABSCESS

### TWO CASE REPORTS

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AND

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**B**RODIE'S abscess is a well localized chronic or subacute, non-specific pyogenic abscess, usually involving the juxta-epiphyseal regions of long bones. Although of rather infrequent occurrence, Brodie's abscess is important because it is often overlooked entirely or wrongly diagnosed. Prompt response to treatment makes early diagnosis essential.

#### LITERATURE

In 1824, Sir Benjamin Brodie<sup>1</sup> treated the first recognized case by amputation of the leg. The patient requested this radical treatment after suffering severe pain for twelve years. Subsequent pathological examination revealed a large, localized, pus filled cavity in the lower portion of the tibia in an otherwise normal leg, which convinced Brodie that such radical treatment was unnecessary and two years later, when a second patient was observed with similar symptoms, he accomplished a cure by trephining the bone. Subsequently, seven patients were conservatively treated by him with recovery in every instance. Brodie<sup>2</sup> described the lesion as follows:

"When the tibia is enlarged, from a deposit of bone externally, when there is excessive pain, such as may be supposed to depend on extreme tension, aggravated at intervals, and these symptoms continue and become aggravated and do not yield to treatment, you may reasonably suspect the existence of abscess in the center of the bone. You are not to suppose that there is no abscess because the pain is not constant, on the contrary, it very often comes

on only at intervals, and in one of the cases which I have related there was an intermission of seven or eight months. After it has lasted a number of years, the pain never entirely subsides, still it varies."

Cases were occasionally reported thereafter and Thompson,<sup>3</sup> in 1906, was able to collect 161 cases from the literature. One abscess of the tibia reported by him was so outstanding that the specimen is preserved in the museum of the Royal College of Surgeons of Edinburgh. This abscess had a capacity of more than 500 cc. and communicated externally by a fistulous opening 2.5 cm. in diameter. It is reported that the patient, a sailor, was able to use his limb quite well and would periodically drain the accumulated pus by removing a wooden plug kept in the opening.

Henderson and Simon,<sup>4</sup> in 1924, reported thirteen cases and collected twenty-six additional ones from the literature. Since then, numerous case reports have appeared, including nine by Piquet and Cyssau<sup>5</sup> in 1928 and twelve by Wagner and Hanby<sup>6</sup> in 1938. In all, we have reviewed 340 cases appearing in the literature since Brodie's original article. (Table 1.)

#### CASE REPORTS

**CASE I.** A white female,\* aged thirteen years, complained of pain in the left hip of two months' duration. The pain was aching and

\* Patient observed in the Surgical Clinic of Harold E. Simon, Birmingham, Ala., prior to his entry into military service.

remittent in character, radiated down the left thigh and was aggravated by walking. One and one-half years previously, she had suffered pain in the same area severe enough to prevent attendance at school for two days; six months and again six weeks prior to admission she had fallen, slightly injuring the left hip. A diagnosis of bone sarcoma had been made elsewhere and amputation advised.

TABLE I  
LOCATION OF BRODIE'S ABSCESS IN 340 CASES COLLECTED FROM THE LITERATURE

|                                   | Collected Cases of Thompson | Collected Cases of Henderson and Simon | Collected Cases (21-31) Since 1924, Incl. Our Own | Total |
|-----------------------------------|-----------------------------|--|---|-------|
| Tibia                             | (108)                       | (31)                                   | (74)  | (213) |
| Upper end tibia.....              | 63                          | 10                                     | 27  | 100   |
| Middle of tibia.....              | 2                           | 1                                      | 6   | 9     |
| Lower end tibia.....              | 42                          | 17                                     | 41  | 100   |
| Tibia (portion not stated).....   | 1                           | 3                                      | 0   | 4     |
| Femur                             | (18)                        | (3)                                    | (29)  | (50)  |
| Upper end femur.....              | 0                           | 0                                      | 11  | 11    |
| Middle of femur.....              | 0                           | 0                                      | 1   | 1     |
| Lower end femur.....              | 18                          | 3                                      | 17  | 38    |
| Humerus                           | (18)                        | (2)                                    | (13)  | (33)  |
| Upper end humerus.....            | 0                           | 0                                      | 7   | 7     |
| Middle of humerus.....            | 0                           | 0                                      | 3   | 3     |
| Lower end humerus.....            | 0                           | 0                                      | 3   | 3     |
| Humerus (portion not stated)..... | 18                          | 2                                      | 0   | 20    |
| Radius                            | (4)                         | (1)                                    | (12)  | (17)  |
| Upper end radius.....             | 0                           | 0                                      | 3   | 3     |
| Middle of radius.....             | 0                           | 0                                      | 1   | 1     |
| Lower end radius.....             | 0                           | 0                                      | 8   | 8     |
| Radius (portion not stated).....  | 4                           | 1                                      | 0   | 5     |
| Calcaneus.....                    |                             |  | 3   | 3     |
| Fibula, not stated.....           |                             |  | 1   | 1     |
| Lower fibula.....                 |                             |  | 1   | 1     |
| Ulna (lower).....                 | 2                           |  | 2   | 4     |
| Patella.....                      |                             |  | 2   | 2     |
| Pubic bone.....                   |                             |  | 1   | 1     |
| 3rd L. spinus process.....        |                             |  | 1   | 1     |
| 12th rib.....                     |                             |  | 2   | 2     |
| Metacarpals.....                  |                             |  | 2   | 2     |
| Cuboid.....                       |                             |  | 1   | 1     |
| Scapula.....                      |                             |  | 1   | 1     |
| Not stated.....                   | 11                          | 2                                      | 2   | 15    |
| Total.....                        | 161                         | 39                                     | 147   | 347*  |

\* Two patients had three cavities each and three patients had two cavities each.

On examination the patient walked with a limp and there was tenderness over the lateral aspect of the left thigh between the iliac crest and the greater trochanter. There was no enlargement of the hip. Roentgenologic examination on March 18, 1938, revealed a fusiform enlargement of the trochanteric area of the left femur. The bone was of uniformly increased density with complete loss of charac-

teristic bone markings. In the central portion of this swelling was a rarefied area 6 cm. in length and  $1\frac{3}{4}$  cm. in diameter. (Fig. 1.) The laboratory findings were normal except for a leucocytosis of 14,800. Brodie's abscess was diagnosed and the femur explored on March 29, 1938, by a vertical incision below the trochanter. The periosteum showed slight inflammatory change; the bone was extremely hard and thickened and in the central portion of the involved area was a long cavity containing cancellous bone and granulation tissue. The cavity was completely uncovered leaving a saucerized defect; the overlying soft tissue was mobilized into this defect and the wound closed. Microscopic examination of the specimen revealed osteosclerosis and chronic inflammation.

Healing took place by first intention and she remained symptom-free for seven months, at which time pain in the left thigh recurred, but not as severe as previously. The pain was aggravated by walking and did not improve with sulfanilamide therapy and injections of staphylococcus toxoid. Tenderness was again noted over the lateral aspect of the left femur and roentgenologic examination revealed a circumscribed area of decreased density in the center of a fusiform enlargement of the upper end of the bone. There was marked increased density of the surrounding bone. (Fig. 2.) The temperature was normal. Except for a hemoglobin of 63 per cent (Sahli), the laboratory findings were within normal limits.

On December 1, 1938, the upper end of the femur was again explored; there was marked increased density and thickening of the bone and a cavity filled with granulation tissue was present. This cavity was uncovered, thoroughly curetted, the defect saucerized and the wound closed without drainage. Pathological examination revealed cortical bone of increased density with fibrosis of the endosteum.

She was again symptom-free for seven months when pain and limping recurred accompanied by slight swelling of the thigh. Roentgenologic examination on August 21, 1939, revealed persistent thickening of the upper 12 cm. of the femur below the trochanter with two areas of decreased density.

At operation, the bone was again markedly thickened and several areas of granulation tissue were present. The periosteum was retracted and a radical excision of the cavity was carried out; all abnormal bone tissue was

removed leaving only a shell of thickened bone on the medial side. The overlying muscles were sutured and the wound closed without drain-

of the wrist. Roentgenologic examination on February 28, 1943, revealed a fusiform enlargement of the lower end of the right radius



FIG. 1. Roentgenologic appearance of upper femur in Case 1 before operation, showing fusiform enlargement with marked thickening of the bone and a central cavity.



FIG. 2. Roentgenologic appearance of the femur in Case 1, seven months after operation, showing recurrence of central abscess.

age. Pathologic examination revealed fragments of dense cortical bone and masses of spongy red tissue interspersed with fragments of cancellous bone. Staphylococci were recovered from culture. Convalescence was uneventful and symptoms have not recurred.

**CASE II.** A male soldier, aged thirty-eight years, was admitted to the hospital complaining of pain in the right wrist of two weeks' duration. The pain was at first deep-seated and aching in character, but soon became so severe that sedation was necessary to obtain sleep. At the age of twelve years there had been transitory pain and swelling of this wrist which subsided with heat and rest. The previous history was negative except for furunculosis of the neck at eighteen years of age. Typhoid fever, recent infections, and injuries to the involved area were denied.

Examination revealed point tenderness over the distal portion of the dorsal aspect of the right radius with limited and painful motion

with moderate thickening of the surrounding bone and a circumscribed area of rarefaction 1.1 cm. in diameter adjacent to the epiphyseal line. (Fig. 3.)

Brodie's abscess was diagnosed and the distal end of the radius was exposed through a dorso-lateral incision and the cavity uncovered. It was lined with granulation tissue and filled with thick, green pus. The cavity was curetted, packed with paraffined gauze and sulfathiazole powder and the hand and forearm incorporated in a cast. Cultures of the pus yielded staphylococcus. Microscopic examination of the bone fragments showed no definite necrosis. The marrow spaces were filled with loose fibrous tissue exhibiting moderate round cell and neutrophilic infiltration. On the thirty-fifth postoperative day, the cast was changed and the gauze removed. Sixty days postoperatively, the second cast was removed. A draining sinus tract persisted and roentgenologic examination revealed a persistent area of rarefaction in

the distal radius surrounded by bone of increased density with a small sequestrum in the center of the cavity. (Fig. 4.) The bone was

before the condition is recognized. Dudley<sup>7</sup> reports a patient who suffered symptoms for twenty years and Choyce<sup>8</sup> reported



FIG. 3.



FIG. 4.

FIG. 3. Roentgenologic findings of Brodie's abscess in Case 11, characterized by a fusion enlargement of the lower end of the radius with a circumscribed area of decreased density surrounded by thickened bone.

FIG. 4. Roentgenologic findings in Case 11, before second operation; a small sequestrum is present in the center of the cavity.

again explored and the sequestrum removed. Sulfanilamide was placed in the cavity, the wound closed and a cast applied.

Convalescence was uneventful. The wound healed without drainage and when last contacted, one year later, the patient was symptom-free and possessed full function of the wrist.

#### SYMPTOMS AND FINDINGS

The characteristic complaints of Brodie's abscess are pain and bony enlargement. These may be present for weeks to years

persistence of the condition for sixty years. In the present series, the duration of symptoms was less than one year in thirty-five cases and exceeded one year in eighty-one cases with an average of 6.3 years. Pain is an early and constant symptom and may be mild and intermittent at the onset, becoming progressively more severe with occasional remissions. It is commonly aggravated by activity or atmospheric changes and is usually more severe at night. When mild, the pain is often dull in

character but when severe and constant, it is frequently boring and stabbing in character and referred to the adjacent joint or the entire limb.

Early in the course of the disease, the patient may be unaware of swelling, but bony enlargement becomes a constant finding with the progressive development of the abscess. Limitation of motion of the adjacent joint or interference with function of the entire limb may develop. Effusion into the adjacent joint is not infrequently observed.<sup>9-12</sup>

Systemic reactions are usually mild or absent unless the infection becomes acute, at which time malaise, headache, loss of weight, mild temperature elevation and increased fatigability may appear. Neutrophilic leukocytosis, rarely exceeding 13,000 to 15,000, may develop.

On examination, fusiform swelling involving the entire circumference of the bone is usually present, and localized tenderness is frequently elicited. The soft tissues are characteristically not involved, but occasionally there may be varying degrees of redness, swelling, tissue thickening and rarely localized fluctuation. Spontaneous development of a draining sinus is exceedingly rare. Limitation of motion of the adjacent joint may be present. In the young, shortening of the extremity may occur in rare instances as a result of interference with a normally growing epiphysis. More rarely, lengthening may occur as a result of hyperemia of the epiphyseal region.

The early diagnosis of Brodie's abscess depends upon the roentgenologic findings. The appearance of a small localized area of decreased density usually near the epiphysis of the long bones with slight thickening of the surrounding bone, are characteristic early findings. Later the cavity appears clear cut and varies from .5 to 7 cm. or more in diameter, surrounded by compact bone. The circumference of the bone is increased due to the expanding nature of the lesion. Sequestration, penetration into the joint, or exten-

sion toward the diaphysis of the bone are rare. Spontaneous fracture has been observed in only isolated instances.

#### PATHOLOGY

In the early cases, the abscess tends to be small and the surrounding bone shows relatively no structural changes or at most only slight thickening. The cavity itself is filled with a homogeneous mass of granulation tissue which microscopically shows numerous loops of newly formed blood vessels with leucocytes and tissue cells all in a state of active proliferation.

As the condition progresses, the cavity becomes more distinct and the surrounding bone shows a corresponding increase in its outer circumference. This bone becomes denser and may approach eburnation; the wall of the cavity becomes sharply demarcated and lined by a pseudomembrane of compact granulation tissue. The contents of the cavity are first serous, then purulent. Chronic infection is manifested by lymphocytic and neutrophilic infiltration of the vasculofibrous lining of the cavity.

Because of its frequent proximity to the joint, irritation of the synovial membrane may occur with effusion into the joint space. The typically slow progress of the lesion results in thickening and expansion of the surrounding bone which prevents fistula formation and sequestration. The periosteum tends to become attached to the overlying bone and is increased in thickness, often presenting a grossly laminated appearance.

#### DIFFERENTIAL DIAGNOSIS

The characteristic symptoms and findings of Brodie's abscess are confirmed by roentgenological studies. The lesion may be mistaken for bone sarcoma and other malignant bone tumors but in these, loss of weight and cachexia appear early and roentgenologic findings and biopsy establish the diagnosis.

Chronic sclerosing osteitis<sup>13</sup> typically involves the medullary portion of the bone

and roentgenologically shows marked thickening and increased density without the fusiform swelling characteristic of Brodie's abscess. Bone cysts can be differentiated by the absence of reaction of the surrounding bone, since here the cavity develops as a result of osseous destruction, frequently with marked thinning of the surrounding bone and without expansion. Tuberculosis of the bone is associated usually with early joint involvement and has more severe localized and generalized reactions. Roentgenologic findings are characteristic. Syphilitic osteitis and periosteitis are likewise diagnosed by characteristic roentgenologic findings and serological reaction and by prompt response to specific therapy.

Other conditions which may be confused with Brodie's abscess are sciatica, bursitis, scurvy, hemarthrosis, rheumatic fever and arthritis.

#### ETIOLOGY

Brodie's abscess occurs predominantly in males. In 134 collected cases in which sex was mentioned, the ratio was 97 males to 37 females. In 133 cases in which the age was mentioned, 119 cases were under, and only fourteen were over, the age of forty years. Forty-seven were between the ages of eleven and twenty; thirty-six between the ages of twenty-one and thirty; and twenty-one were between the ages of thirty-one and forty. (Table II.) The

of sixty-three years. The greater susceptibility of the male and its occurrence most frequently during the age of greatest physical activity suggest trauma as a contributing factor. However, a history of trauma even when present was frequently indefinite, occurred months and years prior to the onset of the symptoms and its significance is questionable.

The lesion occurred in the tibia in 213 out of 332 instances in which location was mentioned, equally divided between its upper and lower extremities. The distal and proximal ends of the femur were involved next in frequency and then the humerus and radius and rarely the calcaneus<sup>14,15</sup> fibula, ulna, scapula,<sup>16</sup> patella,<sup>17</sup> public bone,<sup>18</sup> spinus processes,<sup>19</sup> ribs,<sup>20</sup> cuboid, and the metacarpals. Localization in the mid-portion of a long bone is rare and was observed only nine times in the tibia, once in the femur, three times in the humerus and twice in the radius. The abscess cavities are rarely multiple; two were observed in one patient in three instances,<sup>21,5</sup> and two patients each presented three distinct cavities.<sup>20,5</sup> (Table I.)

Brodie's abscess has been diagnosed frequently when osteomyelitis existed previously in the same location. Thompson found such a history in 122 of his 145 collected cases. Such cases were not included by us as true Brodie's abscesses, but considered residual infection secondary to osteomyelitis. Primary solitary abscesses which co-existed with or followed osteomyelitis but in a different location have been included; there were fourteen cases of this type.

The frequency of acute infections preceding Brodie's abscess is striking, particularly because the organism recovered from the abscess was, in many instances, identical with the organism which caused the preceding infection. In ten instances, the abscess was preceded by typhoid fever and in eight of these *Bacillus typhosus* was recovered from the abscess. In one instance,<sup>22</sup> there was a history of paratyphoid fever two months prior to the onset of

TABLE II  
AGE INCIDENCE OF BRODIE'S ABSCESS IN 140 COLLECTED CASES

| Years           | No. of Cases |
|-----------------|--------------|
| 1-10.....       | 15           |
| 11-20.....      | 47           |
| 21-30.....      | 36           |
| 31-40.....      | 21           |
| 41-50.....      | 10           |
| 51-60.....      | 3            |
| 61-70.....      | 1            |
| Not stated..... | 7            |
| Total.....      | 140          |

youngest patient in the collected series was a boy of one year and the oldest was a man

symptoms and *Salmonella paratyphosus* A was recovered from the abscess. *Escherichia coli* was isolated from one abscess which followed amoebic dysentery. In seven instances acute otitis media preceded the onset of the symptoms and from all of these abscesses staphylococci were recovered. Superficial abscesses of the skin preceded the onset in eight cases and in six of these staphylococcus was found. In eleven instances there was a history of influenza or "la grippe" preceding the appearance of the abscess and in four, staphylococci were recovered. Of the fourteen cases with a previous history of osteomyelitis elsewhere, staphylococci were recovered in nine instances, hemolytic streptococci in two instances and cultures not reported or negative in three instances. (Table III.)

TABLE III  
BACTERIOLOGICAL FINDINGS IN 140 CASES OF BRODIE'S  
ABSCESS

|                                     |     |
|-------------------------------------|-----|
| Staphylococcus— <i>aureus</i> ..... | 52  |
| Staphylococcus.....                 | 21  |
| Staphylococcus—hemolyticus.....     | 3   |
| Staphylococcus— <i>albus</i> .....  | 4   |
| Staphylococcus— <i>citrus</i> ..... | 2   |
| Typhoid bacillus.....               | 7   |
| Paratyphoid bacillus A.....         | 1   |
| Paratyphoid bacillus B.....         | 1   |
| Streptococcus.....                  | 2   |
| Streptococcus—non-hemolyticus...    | 2   |
| Streptococcus—hemolyticus.....      | 1   |
| Pneumococcus.....                   | 2   |
| Colon bacillus.....                 | 1   |
| Negative culture.....               | 7   |
| Not reported.....                   | 34  |
| Total.....                          | 140 |

The predilection of the abscess for the extremities of long bones, in areas which are especially vascular, the greater susceptibility of bones and portions of bones most exposed to trauma, the similarity between the bacteria recovered from the cavity and that of the preceding infection, in some instances definitely hematogenous in character, strongly supports Ogilvie's<sup>23</sup> theory that "the primary lesion is a juxta-epiphyseal strain, a partial injury at the very vascular area plus general lowered resistance in the presence of foci elsewhere."

## TREATMENT

Brodie's first patient was treated by amputation. Subsequently, patients have been treated by trephining, plombage or filling of the cavity with paraffin, oils or antiseptic pastes, unroofing of the cavity and obliteration with chips of bone, grafts of muscle or fat, with primary closure or prolonged packing with gauze according to the Orr method. Vaccines as an aid to control infection have been tried with questionable benefit. Palliative measures such as rest, heat, diathermy and application of casts resulted in only temporary relief of symptoms.

The present methods of treatment consist of complete excision of the cavity with saucerization of the bone defect and primary closure after obliteration of the cavity by mobilization of the adjacent soft tissue. The local use of sulfonamides supplemented in many instances by their systemic administration preoperatively, postoperatively, or both, is indicated. Rarely, as in the presence of a draining fistula or when a more acute process exists, packing of the wound with gauze for varying periods of time with secondary closure, as was done in the two reported cases, may be indicated. Application of a cast postoperatively for a period of two to three weeks is indicated to accomplish rest and provide support for a bone which may have been weakened by surgical procedures.

## PROGNOSIS

The prognosis is excellent. Reoperation may be necessary for persistent draining sinus, sequestrum formation, or when there is extensive chronic infection of the surrounding bone. In the absence of these conditions there is little or no tendency to recurrence. Amputation is never necessary and fatal termination has not been observed in any of the 340 cases reviewed.

## SUMMARY AND CONCLUSIONS

Two cases of Brodie's abscess are reported and 340 cases reviewed from the literature.

The etiology, pathology, symptoms, findings and treatment are discussed. The importance of early diagnosis and differentiation from other bone lesions is stressed. The disease is benign and probably of hematogenous origin and trauma is considered to be only of localizing importance.

Surgical intervention with complete removal of the abscess wall, saucerization of the wound and obliteration of the defect are essential to accomplish cure; the local and general use of sulfonamides is beneficial. Primary closure of the wound is usually preferable to drainage and secondary closure.

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CHRONIC osteoperiostitis usually begins as a periostitis, involving by extension the haversian canals and medulla, and producing a general sclerosis and thickening of the bone. It may be (a) diffuse, or (b) local, and may follow trauma, rheumatism or syphilis.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# CONGENITAL EVENTRATION OF THE DIAPHRAGM

## SURGICAL MANAGEMENT

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A CASE of eventration of the diaphragm in an infant which was cured by operation is reported

Eventration of the diaphragm may be defined as an abnormally high or elevated position of one leaf of the diaphragm as a

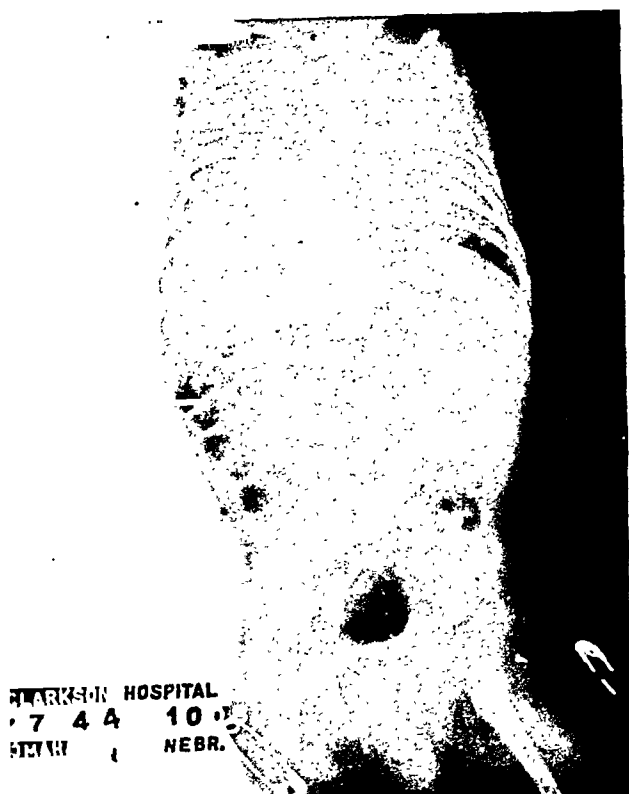


FIG. 1. Preoperative film. The right diaphragm is elevated to the level of the posterior portion of the fifth rib and the heart and mediastinum are displaced to the left. The area of cardiac dullness extends to the left costal margin with only a small segment of unobscured lung in the left costal-phrenic sinus. The inferior margin of the liver is above the eleventh rib.

because, (1) the writers are unable to find a report of a previous attempt to treat this condition in an infant by operation and (2) they suspect that some of the deaths in the newborns which are attributed to other causes of cyanosis and dyspnea are in reality the result of unrecognized congenital eventration, which, as in our case, have prospect of surgical cure.

result of paralysis, aplasia or atrophy of the muscle fibers but with no break in the continuity of the leaf. Its unbroken continuity differentiates it from diaphragmatic hernia. Admitted by all authors an inappropriate term, eventration has been established by general use and the lack of a better name. The condition has been observed in people of all ages and, although

this paper is concerned with the problem in infants, it is necessary to refer to subject matter which deals with the subject as a whole.

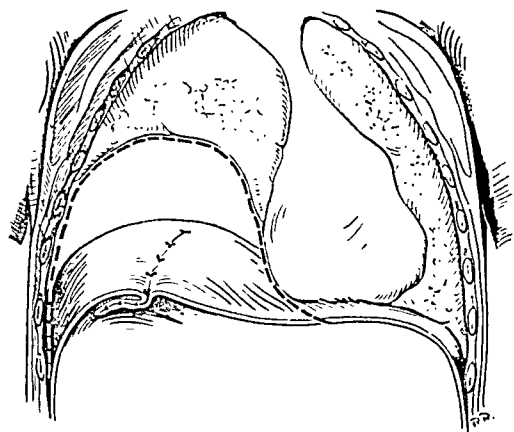


FIG. 2. Diagrammatic representation of the position of the diaphragm (dotted line) and the resultant distortion of the intrathoracic viscera. This is also illustrated in the procedure used in the writer's case. Shortening was accomplished by plication with three superimposed rows of interrupted mattress sutures through an intrathoracic approach.

Bibliographers have credited Petit with the first description of the condition. A case report with postmortem findings appeared in the posthumous edition of his work published in 1774. Infrequently thereafter, isolated cases were reported and in 1913 Bergman reviewed the literature to that date and collected thirty-one cases. Three years later Bayne-Jones reported a collection of forty-five cases including one of his own. In 1921, Korn was able to assemble sixty-five cases and in the most recent collection Reed and Borden, in 1935, reported 183 cases.

Most of the reported cases were adults and it is probable that in most of them the lesion was acquired. A few were incidental findings and presumably caused no symptoms. The remaining cases presented a variety of symptoms which fall into four general groups: (1) gastric, (2) cardiac, (3) pulmonary and (4) pleuropulmonary.

If the number of case reports is a criterion, eventration in infants is indeed a rarity. In his review of the literature up to 1916 Bayne-Jones collected three cases:

a fetus, a newborn, one day old, and an infant of three months. In each instance the diagnosis was made at postmortem examination. In the eighty-three cases collected from the literature from 1921 to 1935 by Reed and Borden there were only five infants. From 1935 to 1945, at least nine additional cases in infants have been reported including our case. Undoubtedly these figures give a very inaccurate conception of the incidence. In addition to the unreported cases it is very probable that some of the deaths in infants which have been attributed to other causes of cyanosis and dyspnea have in reality resulted from eventration.

The writers' case was unusual in that the right half of the diaphragm was involved. Of the 183 cases collected by Reed and Borden only eighteen were on the right side.

The symptoms in the infants, when recorded, were cyanosis and dyspnea as in our case.

At postmortem examination the elevated half of the diaphragm has presented varying degrees of atrophy; in the extreme a very thin fibrous membrane was present with complete absence of muscle fibers. Not infrequently there are associated maldevelopments of the lung, heart or liver, failure of intestinal rotation or unassociated congenital deformities as cleft palate.

In the series of 183 cases reviewed by Reed and Borden direct operative attack upon the diaphragm was done in only four cases. Reports of two additional cases were found in the literature which has accumulated since 1935. In all cases the diaphragm was lowered by shortening, in one case by excision of a segment and in five by plication. One patient was plicated from the abdominal side, the others from above through an intrathoracic exposure. One died three days after operation and the others obtained partial or complete relief of symptoms. The ages of these patients varied from ten to forty-four years.

So far as we were able to ascertain from a careful review of the available literature,

our case is not only the first recorded instance of a surgical cure of this condition in an infant but also the only record of

survival possible there was no improvement in the infant's condition after one week so he was brought to the hospital.

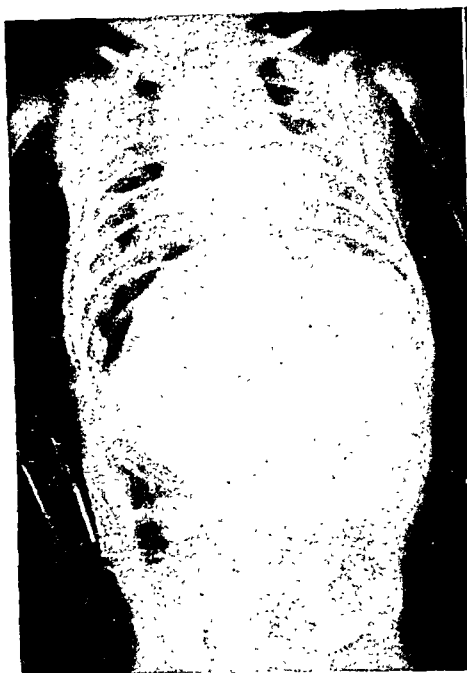


FIG. 3. This roentgenogram made immediately following operation shows the right diaphragm lowered to a position below the left with complete aeration of both lungs and normal intrathoracic relations. The inferior border of the liver is several centimeters below the twelfth rib.



FIG. 4. At the time of dismissal from the hospital, ten days after operation, the lowered position of the right diaphragm was still well retained.

operative intervention in a case in this age group.

#### CASE REPORT

Baby W., a male infant six weeks old, was brought to the Bishop Clarkson Memorial Hospital in an improvised oxygen chamber. He was born at full term without operative assistance and appeared normal at birth. On about the tenth day after birth the mother became impressed that respiration was somewhat labored and that cyanosis developed when the infant cried. Feeding became progressively more difficult and he failed to gain weight.

By the fifth week after birth the dyspnea and cyanosis had increased to such an alarming degree that it was necessary to administer oxygen. The father, who is an automobile mechanic in a rural community, fashioned a very satisfactory oxygen tent with the help of the family physician. Although the tent made

Examination showed a well developed but poorly nourished infant of six weeks showing moderate dyspnea and rather marked cyanosis both of which became very marked with crying and exertion. The right side of the chest moved less than the left and there was lateral retraction with inspiration, also obvious use of the accessory muscles of respiration. There was dullness to percussion and absence of breath sounds below the level of the second rib anteriorly on the right side and in the upper two-thirds of the left chest. The liver was not palpable but the spleen extended 4 cm. below the left costal margin.

The weight was six pounds and fifteen ounces, the temperature 97.2°F., the urine negative, the blood hemoglobin 12.7 Gm. and white blood cells 24,800 with 55 per cent segmented, 20 per cent staff forms, 5 per cent monocytes, 2 per cent eosinophils and 18 per cent lymphocytes.

An x-ray film of the chest and abdomen (Fig. 1) showed the right diaphragm elevated to the level of the fourth rib posteriorly. There

was increased density of the right lung, probably from compression and an enlarged heart shadow which was displaced to the left to the



FIG. 5. This roentgenogram made five months following operation shows the right diaphragm at the level of the ninth rib, one interspace higher than the left, presumably indicating that some giving way or relaxation has taken place. The writers are unable to explain the wedge-shaped shadow extending out from the right hilum and the broadened area of supracardiac density; possibly thymus. Note that the eighth and ninth ribs have become broader and fused as a result of the operative trauma.

extent that it was in contact with the left costal border. Evidence of aeration of the left lung was apparent at the inferior angle only. The liver shadow was displaced upward with its lower border above the costal margin.

A diagnosis of either eventration or hernia of the right diaphragm was made and surgical exploration undertaken July 29, 1944. Oxygen was administered with positive pressure through a mask in a closed system and the skin and underlying tissues of the right ninth intercostal space infiltrated with 0.5 per cent novocaine solution. Through this interspace the pleural cavity was opened and adequate exposure obtained with a small rib spreader.

The right diaphragm was intact throughout; that is, there was no break in its continuity. Its apex extended to the second rib anteriorly. Its excursion, though almost negligible, was not paradoxical. Except for pallor it appeared to be fairly normal and obviously it consisted of

muscle. On casual observation there was discerned no abnormality of the right lung.

The diaphragm was shortened and brought down to the level of the tenth rib by plication with three superimposed rows of interrupted mattress sutures of silk extending diagonally from the costal attachment in the region of the nipple line posteromesially to the aperture for the vena cava as illustrated in Figure 2. The pleat was turned downward between the diaphragm and liver. The chest wall was closed with pericostal sutures and silk was used in the muscles and skin.

There was complete relief of dyspnea and cyanosis immediately following operation and from then until the time of this report (seven months after operation) respirations have continued to be normal. Also in every other respect the infant appears to be normal and is growing and gaining weight at a normal rate.

Roentgenograms of the chest immediately following operation and at periods subsequently are illustrated in Figures 3, 4 and 5. It will be observed that with the return of the diaphragm to its normal position the intrathoracic organs have likewise resumed their normal positions and both lungs are completely aerated. In the last roentgenogram the right diaphragm is one interspace higher than the left.

#### COMMENT

It is probable that the writers' case was more amenable to surgical therapy than most cases because the diaphragm contained muscle and had considerable substance in which the sutures were well retained against tension. Much less might be expected of cases in which the diaphragm is a very thin fibrous membrane as has been revealed in a few instances at post-mortem examination.

#### CONCLUSIONS

1. A successful operation and an apparent cure of eventration of the right diaphragm in an infant is reported.
2. As judged from reported cases, it is a relatively rare condition in infancy. The writers believe that some infant deaths result from unrecognized eventration of the diaphragm.

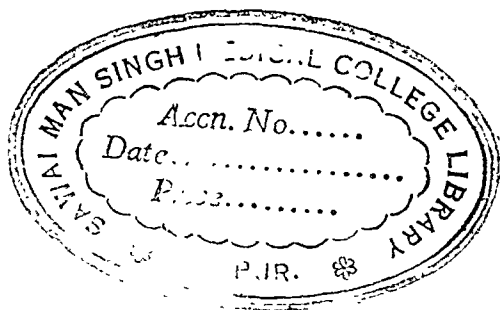
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UMBILICAL endometriosis presents in the form of small nodules which may, when they approach the surface or when the abdominal wall is very thin, be of blush hue. They increase in size at the menstrual periods, when they become tender and painful. They sometimes break through the skin, with periodic external bleeding.

From "Textbook of Gynecology" by Emil Novak (The Williams & Wilkins Company).



# CRIMINAL ABORTION

## THREE CASE REPORTS

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WHEN we realize that there are over half a million abortions each year in the United States with more than 8,000 deaths, or 1.2 per 100 abortions, with a marked increase in the last twenty-five years, and that criminal abortions make up from 70 to 80 per cent of these cases, it is remarkable that we do not have more instances of foreign bodies in the uterus, and especially in the peritoneal cavity as a result of these attempts. They present serious problems in diagnosis and a grave responsibility in their management; yet comparatively few reports of such cases with their attendant serious consequences have appeared in the recent literature. Most of the reviews have been on the social and statistical aspect of abortions.

Quite a few years ago Professor Lewis in his book "Die Fruchtabtreibung durch Gifte und andere Mittel" recorded a vast literature on the abortion problem. Katz, in 1922, collected and reported fifty-four cases of criminal abortions with the passage of the instruments used into the peritoneal cavity. J. N. M. Ross and P. D. McLellan, in the *Lancet* of June 13, 1942, report a foreign body in the abdomen that migrated to the rectus muscle near the liver, following a penetration of the abdomen in a criminal abortion. A. H. Kanter reported a case in the *Ohio State Medical Journal* of November, 1943, somewhat similar to our second case.

Because of the meagerness of reports of such cases in recent years, we believed it appropriate to report these three cases:

### CASE REPORTS

CASE 1. The first case is a young woman, age twenty-two years, who was admitted to my

service at St. Agnes Hospital with the chief complaint of vaginal bleeding and suprapubic pain. Because she thought there was "something like a clot in her womb," she used a pair of eyebrow tweezers to remove it, during which the tweezer disappeared. (The patient's story changed so often that we considered it absolutely unreliable). She said her last period was three weeks ago (this was not true). Her temperature on admission was 99.2°F.

Examination showed a patient of normal development but nervous and mentally distressed. Tenderness was present over the suprapubic region. The uterus was the size of a three months' pregnancy, the external os was slightly patulous with moderate bleeding.

X-ray of the abdomen was taken; it showed the tweezer with the open end pointing cephalad.

Treatment consisted of sulfadiazine intravenously, sedation and exploration of the uterus.

Operation was done seven hours after she inserted the tweezer. Under gas anesthesia pelvic examination revealed a soft uterus about the size of a three months' pregnancy with the external os patulous and a moderate ooze of blood. The tweezer was palpated near the cervix; this was grasped with a clamp and removed. A small fragment of tissue, which was uterine content, was taken for examination. No drains were used. There was no abnormal bleeding.

The pathologic report showed chorionic villi, syncytial cells and infected blood clots.

Misinterpretation of the x-ray picture almost led to a serious accident in removing the tweezer. As seen on the x-ray the open end was directed cephalad, from which we assumed that this open end pointed toward the fundus, and the closed end toward the cervix. It should have been easy, therefore, to grasp the closed end and pull it out of the uterus, the blades would thus be compressed in its passage through the cervix. Fortunately, however, after the pal-

pated end of the tweezer was grasped by a clamp and traction was begun we saw that one of the prongs and not the joined end had been grasped. Had this traction been continued the

rod when she sat down. She felt no pain at any time.

Examination showed vaginal bleeding less in amount than a normal period; the uterus was

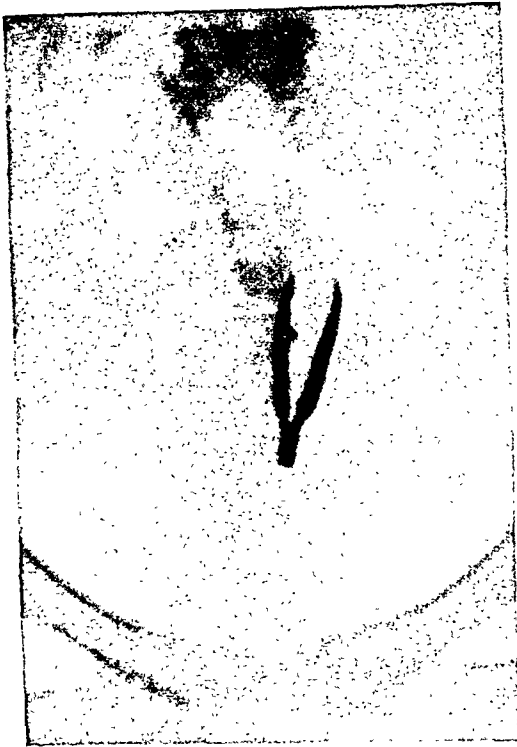


FIG. 1. CASE I. Tweezer in uterus.

other prong would have been pulled through the uterine wall. This was obviated by closing the tweezer before removing it.

In spite of our warnings of the possibility of infection and hemorrhage, this patient left the hospital eight hours after the removal of the tweezer, with a temperature sharply elevated. A number of days later she entered another hospital with a septic abortion, but eventually recovered.

**CASE II.** This second case is that of a woman, age thirty-four, admitted to the service of Dr. William R. Nicholson at the Graduate Hospital, with the chief complaint of a glass rod in her vagina. She said that she began to menstruate two days ago and because she was out of tampons she decided to use cotton, packing it into the vagina with a glass cocktail stirring rod. The rod accidentally slipped up into her vagina and she was unable to find it. She went to work, but later she became so frightened that she decided to come to the hospital. She said she could definitely feel the

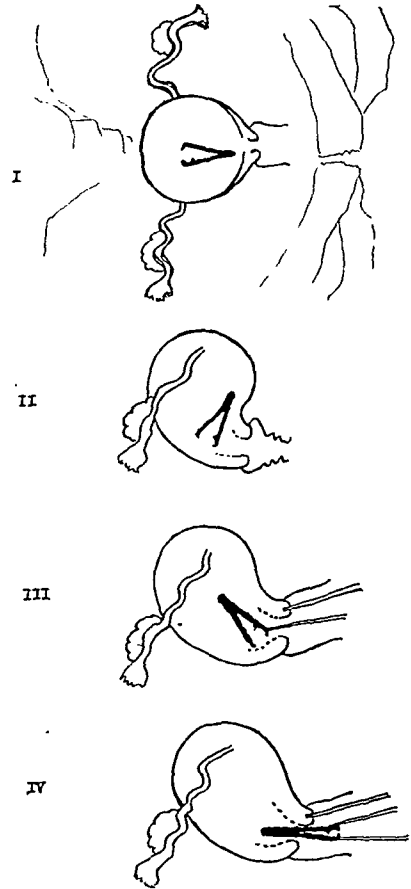


FIG. 2. I, Top view; open end of tweezer points cephalad; this is in relation to bony pelvis. (X-ray—same view.) II, Side view; although open end points cephalad, it is directed toward the cervix rather than the fundus. III, Side view; tenaculum on anterior lip; traction has increased the cervicocorporeal angle so that prong of open end is brought into close relation to internal os. A long hemostat is used to grasp prong; pull on this revealed its identity (open end). Continued traction would have pulled other prong through wall. IV, Side view; other prong also grasped with long hemostat, both blades compressed, tweezer removed.

acutely retroflexed. A pencil like object could be felt extending from the right iliac crest to the posterior cul-de-sac. It was movable and could be felt in its entirety. We could not



locate the point of entrance. Rectal examination with a scope was negative. (There was the possibility that this rod might have entered

was done and found to be positive. Her recovery was uneventful. The highest temperature was 101°F. by the second day and normal by the



FIG. 3. Case 11. Glass rod in abdomen.

the bowel through the rectum, though remote because of its location on right side). The abdomen was normal except that one end of the rod could be palpated.

X-ray was taken. A rod in the left pelvic cavity, which probably perforated the left vaginal wall, was reported.

Her temperature was 99.2°F., red blood count 3,000,000, and white blood count 10,050. Sulfadiazine was given intravenously.

An abdominal operation was done six hours after admission. A small abdominal mid-line incision was made. The blue crystal cocktail stirring glass rod six inches long was found free in the peritoneal cavity, its upper end near the liver. There was no blood in the peritoneal cavity. The uterus was acutely retroflexed, about four to six weeks pregnant. The site of perforation was found on the anterior wall of uterus; it was 1 cm. in size, covered with a bluish clumped exudate with early signs of healing. The omentum was free; no other injuries were found. A few mattress sutures were used to reinforce the rent (which was already sealed).

Five days after operation a Friedmann Test

fifth day. She was discharged on the fourteenth day.

This woman suffered no pain and developed neither hemorrhage nor infection. The glass cocktail stirring rod may have been procured from a cocktail just prior to its use, so possibly sterile therefrom. The glass rod was made of blue glass, pigmented; this made the x-ray picture possible (it might otherwise not have cast a shadow).

It is interesting to note the co-incidental finding of an acute retroflexion so that the rod went through the anterior wall of the uterus in its lower segment. This part of the uterus was very soft and thin because of the pregnancy. In its passage the glass rod missed the growing embryo; the sac itself evidently was unharmed. Only a slight bloody stain was noted per vagina.

The patient did not bleed vaginally post-operatively; a Friedmann Test was done five days later which was positive. The size of the uterus was unchanged upon discharge, so she was told that very likely she would continue with her pregnancy, to which she replied that she was very happy this was so. However, four

months later examination showed the uterus to be small and almost normal again. Of course she denied having had a further abortion or may be of interest to note that in both these cases the rods found their way toward the undersurface of the liver.



FIG. 4. Case III. Glass rod with upper end free in peritoneal cavity, its lower end in wall of uterus.

any history of bleeding or pain after she left the hospital, all of which, however, is questionable.

CASE III. With the permission of Dr. Neese and Dr. Oaks of the Graduate Hospital, I wish to present the x-ray picture and a brief resumé of a case in which the patient was operated upon by them at the American Stomach Hospital, because it apes Case II very closely. This patient also used a cocktail glass stirring rod to abort herself, of a larger size, however, 20 cm. long. Except for moderate vaginal bleeding and mild abdominal cramps, she likewise exhibited very little in the way of internal hemorrhage or infection, or even peritoneal irritation. Her cramps were probably due to the expulsive effort of the uterus, because the lower end of the rod was still held by the fundal wall while its upper end was found at the base of the liver. In Case II the rod was shorter, 10 cm. in length, and entirely free in the abdomen. It

This patient made an uneventful recovery and left the hospital still pregnant. She was seen a few months later with a pregnancy that was progressing normally, but unfortunately the ultimate outcome of her pregnancy is not known because she registered elsewhere for her delivery. So far attempts to locate her have failed.

These cases show to what length some women will go to rid themselves of undesired pregnancies. The methods used are evidence of the desperate state of mind of these women who so willingly face self-destruction in their efforts to terminate a pregnancy. Many women who wish to have no more children train themselves to feel for the location of the cervical orifice and without any effort toward sterilization

slip instruments within the cervical canal and successfully terminate their pregnancies.

The trend in modern times has been instrumental interference by a trained abortionist. The intra-uterine injection of soap solution or glycerine seems to be the preferred method, despite the danger of infection, cauterizing action and risk of pushing some of this solution through the tubes into the abdomen. Air embolism from these syringe paste methods is a possibility.

It is not unusual to find a tubal pregnancy instead of an intra-uterine pregnancy in cases of attempted abortion, and it is ironic that often women go through severe unnecessary torture and expense when they are not pregnant at all.

Perforation of the uterus is the commonest accident of illegal abortion with infection usually added. In perforations from criminal abortions, the sooner a laparotomy is done, the better, because of potential infection. The amount of surgery, such as the mere sewing of the rent in the uterus, drainage or hysterectomy, depends on how soon after the accident the operation is done and how much injury there is to the viscera.

If the foreign body is not removed, it becomes encapsulated after the peritonitis has subsided. Months or years of localized infection may be the patient's lot. When recovered from perforation with or without operative intervention the sequelae may effect the general health by residual chronic pelvic infection. It is not unusual to find a uterine wound that shows imperfect

healing, and rupture of the uterus may occur in a subsequent pregnancy.

#### SUMMARY AND CONCLUSIONS

The first case in which an eyebrow tweezer was used in an attempted criminal abortion emphasizes the need of thorough study of x-rays to ascertain the direction of such a double-pronged sharp instrument, so vitally important in its removal. A mere flat film is not all revealing because of the variation in position of the uterus. The relationship of a foreign body to the uterus is the important factor and not its relation to the bony pelvis, such as a flat plate would give us.

The other two cases in which attempted criminal abortions by glass cocktail stirring rods resulted in perforation of the uterus, passage of the glass rod into the abdomen and no interruption of the pregnancy, illustrate (1) the ease with which foreign bodies can perforate a uterus without unduly alarming a patient as from pain or hemorrhage; (2) the amount of trauma a pregnant uterus can stand without necessarily causing it to abort, and (3) the efficacy of modern drug therapy and early operation.

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# TORSION OF THE TESTICLE

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THIS clinical entity, although not by any means common, is certainly not as rare a condition as it was considered a decade or so ago; for although V. J. O'Connor,<sup>8</sup> in 1919 reported a total of 124 cases on record, Abeshouse<sup>1</sup> in his complete review of the subject reported in 1936 a total of 350 cases including three cases of his own. This fully illustrates an increased awareness of the condition. However, failure of a large number of these cases to be diagnosed promptly and early, indicate that the diagnosis is not considered as soon as it should be. It is important that this diagnosis always be borne in mind because of the serious sequelae both psychological and physiological that may ensue, following an incorrect diagnosis or failure to institute proper treatment immediately after making the diagnosis. It is for the purpose of bringing to mind the possibility of this condition, that this case history and résumé of the entity itself is reported.

The etiology has been generally recognized as being for the most part due to congenital anomalies of both the scrotum and its contents and anomalies in the descent of the testicle itself. In general, the anomalies are considered as being a hypermobility of the testicle and its presence in an enlarged scrotum.<sup>3,4,7,9</sup> A question of hypermobility is best explained on the basis of the anomalous descent of the testicle in which the testicle and the epididymis become completely surrounded by the tunica vaginalis, allowing the testis, epididymis and the distal spermatic cord to become an intravaginal body, without any lateral or posterior attachments, being attached to the base of the scrotum only by the remnants of the gubernaculum. The high attachment of the tunica vaginalis allows some of the lower fibers of the

cremasteric muscle to be inserted inside the vaginal sac. Spasm of the muscle itself associated with a firmer contraction of one group of fibers may result in rotation of the spermatic cord, testicle and epididymis inside the vaginal sac, resulting in a torsion. Accepting this explanation as the cause of torsion, it is easy to comprehend why the condition may be relieved spontaneously in some cases while in others the torsion may cause continued spasm of the cremasteric and thus maintain the torsion. This theory seems the most likely one and was offered by Muchat<sup>7</sup> in 1931.

It must be realized that in addition to the congenital anomalies present, extrinsic factors may play an important rôle in inducing the condition. Of these factors, trauma and sudden muscular exertion appear to be predominant. The incidence of torsion in the fully descended testicle as against the undescended testicle remains an undecided point, some authors claiming as high as 50 per cent of torsion cases being in the undescended testicle.<sup>11</sup> It is in the fully descended testicle, however, that the best results can be obtained by early, correct diagnosis and treatment; yet it is in the fully descended testicle that diagnosis and proper treatment so often is delayed.

The age at which torsion of the testicle occurs is extremely variable for Hegner and Postma<sup>5</sup> report a case occurring at the age of four months and Wolf<sup>13</sup> reports a case at the age of sixty-eight years. V. J. O'Connor,<sup>8</sup> in 1919, stated the average in the 124 cases, however, occurred at the age of or just before puberty.<sup>8</sup>

The diagnosis in the fully descended testicle need not be too difficult just so long as the entity is borne in mind. In the case of the undescended testicle, its absence from the scrotum makes the differentiation between torsion of the testicle and a

Richter's hernia well nigh impossible in cases producing like symptoms. Cardinal symptoms of torsion in the fully descended testicle are a sudden onset of pain, the retraction of the testicle upward in the scrotum, swelling and tenderness. There may be nausea and vomiting and occasionally some chills with fever of a mild degree. Laboratory tests are negative at the onset unless there is concurrent disease.

The differential diagnosis presents its main problem in the consideration of an acute epididymitis. The lack of a history of infection, the sudden onset without temperature or increase in blood count, plus the physical findings will usually rule out an epididymitis. In addition, the testicle itself is tender and swollen in a case of torsion which is not the rule in a case of epididymitis at the onset. A useful diagnostic point between these two conditions is Prehn's sign,<sup>6,10</sup> namely, that in torsion cases the more the scrotum is elevated, the greater is the severity of the pain; which contrasts with the relief of pain with elevation of the scrotum in epididymitis. Orchitis and tumor of the testicle offer a similar differentiation. Physical examination of external rings will rule out a strangulated hernia when negative.

The condition encountered in an acute case of torsion which is not relieved immediately corresponds to that seen in a strangulated hernia. The vessels are deeply congested and prominent, small petechial hemorrhages are visible and the epididymis and testicle are swollen, and as the time interval increases, the color passes through the stages of cyanosis to that of complete gangrene. The testicle and epididymis then undergo an aseptic necrosis with softening of the parenchyma followed by a gradual replacement of the structures with fibrous tissue.

The treatment of acute torsion is decidedly surgical, although cases have been reported in which early manual detorsion has been successful.<sup>12</sup> The torsion is, of course, prone to recur and the process of detorsion is not always successful because

it is impossible to determine accurately the number of degrees which the torsion has undergone and the direction in which it has occurred.

If detorsion is successful, the pain is immediately relieved; but again a partial detorsion may cause a marked reduction in pain and yet strangulation is present as is shown in the case presented here.

Surgical treatment, if instituted early, offers the only certain method of saving the testicle. The technic of surgical interference is variable, but must satisfy the two requirements of complete detorsion and attachment of the testicle to the scrotum in such a fashion as to preclude recurrence. If surgical treatment has been delayed and detorsion does not result in restoration of circulation and normal color, orchidectomy should be performed. Many men have advocated the prophylactic exploration of the opposite testicle and surgical correction of anomalies predisposing to torsion if present.<sup>2,4,6,9</sup>

The loss of one testicle results in no great physiological change so long as the opposite is normal and functioning; but in an individual who has previously lost the function of the other testicle, torsion is a major catastrophe. Psychologically, the loss of even one testicle is of major importance to the individual.

#### CASE REPORT

A soldier, age twenty-four, white, admitted to the hospital August 15, 1944, with the diagnosis of non-union of the left clavicle. The patient was injured in September, 1943, when he fell and fractured the left clavicle. Since that time he had moderate pain in the left shoulder region and tenderness over the junction of the middle and outer third of the left clavicle. Since the injury, he experienced difficulty in lifting and in doing heavy work. His past history was essentially normal except for attacks of tonsillitis and a fracture of the right clavicle in 1932. Physical examination revealed only moderate, bilateral enlargement of the tonsils and a small enlargement of the right testicle which was considered a small hydrocele. There was a deformity over the

middle third of the left clavicle with motion at the fracture site. The x-rays showed a non-union, middle third of left clavicle with a pseudo-arthritis. The patient had an inlay bone graft of the left clavicle on August 23, 1944.

Progress was uneventful until October 16, 1944. At 3.00 A.M. October 16, 1944, the patient awakened from his sleep and started to get out of bed to go to the lavatory when he experienced a sharp pain in the right scrotum, became nauseated, and started vomiting. He was examined at 3.15 A.M. at which time the physical findings were a localized tenderness of the right testicle which was slightly enlarged. Pressure on the testicle made the patient even more nauseated and brought on a spell of vomiting. There was no redness or inflammation present. A diagnosis of torsion of the testicle was made. Upon rotating the right testicle laterally (counter-clockwise) the pain increased, but on rotating it medially (clockwise) the pain lessened. The right testicle was rotated 180 degrees medially and the pain and nausea disappeared. The patient felt comfortable. At 4.30 A.M., the patient had a recurrence of the original pain with nausea and vomiting. Examination at this time showed a drawing up of the right testicle with markedly increased tenderness of the testicle over the previous examination, and a beginning tenderness of the cord just below the external ring. The testicle did not appear any larger than on the previous examination. Elevation of the scrotum did not relieve the patient's pain. An attempt was made at detorsion but there was no decrease in pain on rotation of the testicle through 180 degrees either counter-clockwise or clockwise. Because of the marked nausea and vomiting, a flat plate of the abdomen was taken to rule out an atypical ureteral stone. This was negative. Following the x-rays, the patient's nausea and vomiting decreased and it was believed that the patient should be observed. The testicle was still very tender. His general condition improved in the next twenty-four hours but there was still an occasional spell of nausea and vomiting.

Examination on October 17, showed similar findings with an increased enlargement of the right testicle and increased tenderness of the cord below the external ring. He was operated upon October 17th, under local procaine anesthesia. The incision was made in the right

scrotal sac. Upon incising the tunica vaginalis, the testicle was found to be rotated 360 degrees counter-clockwise and was found to be an intravaginal body. The testicle was markedly discolored from dusky red to definitely blue and black areas. The torsion was reduced and the testicle observed over a period of twenty minutes when it showed a marked increase in circulation with a beginning return to normal color. Due to the return of circulation, it was thought that orchidectomy was not indicated. Andrew's bottle operation for hydrocele was performed. In addition, a mattress suture of silk was introduced through the lower pole of the testicle which was anchored to the dependent portion of the right scrotum. The scrotum was then closed leaving a small penrose drain in the dependent portion of the wound.

Convalescence was uneventful with the exception of a localized edema of the prepuce which lasted until October 24th. The drain was removed on October 20th. The patient was up and around on November 2, 1944, with the wound completely healed. The testicle had not quite returned to normal size and no pain was experienced on compression. He was seen on December 19th and the testicle was found to be about the same size as the one on the left. There was tenderness on compression of the epididymis on the right but none on compression of the right testicle which was quite firm in consistency. Aspiration of the right testicle was done under local anesthesia and the laboratory reported in the stained smears "evidence of spermatogenesis, several cells were identified with rudimentary tails which were thought to be spermatids undergoing transformation to spermatozoa."

#### SUMMARY

1. Torsion of the testicle is not a rare condition and the diagnosis should always be considered in cases of testicular pain.
2. Successful treatment of torsion is immediate surgery with detorsion and fixation of the testicle to prevent recurrence.
3. Orchidectomy may be avoided by early diagnosis and the institution of immediate surgery avoiding all procrastination.
4. In cases of doubt as to the absolute certainty of the diagnosis, surgical exploration under local anesthesia of the involved testicle is advised.

5. A case of torsion of the right testicle in which manual detorsion was unsuccessful and in which surgical detorsion accompanied by fixation of the testicle was successful is presented for record.

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It is of the highest importance that prostatectomy should neither be attempted in the presence of gross infection nor until it has been proved that renal function is adequate. Preliminary ligation and division of the vasa deferentia has banished the troublesome complication of post-operative epididymo-orchitis.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# GRANULOCYTOPENIA COMPLICATING SULFADIAZINE THERAPY IN A SEVERE INTESTINAL INJURY

REPORT OF A CASE IN WHICH PENICILLIN WAS EMPLOYED TO SUPPLEMENT OTHER THERAPEUTIC MEASURES

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THIS case is reported because of the following interesting features: (1) Multiple perforations of both the large and small intestine from a 30-calibre machinegun bullet were successfully handled in accordance with generally accepted surgical principles. (2) The complicating peritonitis, secondary to widespread soiling of the peritoneum, was successfully combated by means of combined sulfonamide and penicillin therapy without a residual abscess formation or complicating wound infection. (3) An unusual urinary tract complication, due to coincidental injury of the parasympathetic nerves in the sacral plexus, was encountered. (4) A severe granulocytopenia developed as a complication of the sulfonamide therapy. (5) Penicillin was employed as an adjunct to other therapeutic measures in the management of the complicating agranulocytosis.

## CASE REPORT

A twenty-five year old soldier was admitted to this hospital at 9 P.M. on December 29, 1943, because of intra-abdominal injuries sustained two hours previously from accidental shooting with a 30-calibre machinegun bullet fired at point blank range.

Physical examination revealed a patient in severe shock. The pulse rate was 136 and quite thready. The blood pressure at first could not be registered, but after a short time was recorded at 90 systolic and 60 diastolic. The wound of entrance was a ragged hole about 1.0 cm. in diameter in the right lower quadrant of the abdomen from which came a moderate bloody ooze. The wound of exit was in the left sacral region, where there was another ragged hole approximately 1.5 cm. in diameter.

After the administration of two units (500

cc.) of plasma, his condition had improved to the point where it was believed that surgery could be instituted. At that time his pulse rate was 104 and the blood pressure was 100 systolic and 70 diastolic; 500 cc. of citrated whole blood was administered during the operative procedure as well as one additional unit (250 cc.) of plasma.

Under ether anesthesia, the abdominal cavity was entered through a right lower paramedian incision. Hemorrhage had been profuse, due to bleeding from several large vessels in the mesentery of the terminal ileum and sigmoid. There was also a moderately severe ooze from the retroperitoneal wound deep in the hollow of the sacrum. Examination showed one perforation in the cecum, three in the terminal ileum, two in the sigmoid colon, and two in the rectum just above the peritoneal reflection. (Fig. 1.)

There was gross fecal contamination, and a considerable quantity of fecal material was removed from the peritoneal cavity during the course of the operation. The perforations in the rectum, cecum, and ileum were closed using atraumatic No. 0 chromic catgut. The damaged mesentery of the ileum was also repaired. The involved sigmoid loop was exteriorized after approximation of the proximal and distal limbs to facilitate the later application of a spur crushing clamp. The colostomy loop was brought out through the main incision. Two cigarette drains were inserted into the retroperitoneal wound, and two additional cigarette drains placed in the bottom of the pelvis. These were brought out through the lower angle of the operative incision. Prior to closure, 12 Gm. of sulfanilamide powder were placed in the peritoneal cavity. The wounds of entrance and exit were then débrided and packed loosely with vaseline gauze. At the conclusion of the operation, which took one and three-quarter hours, the pulse rate was 128 and the blood pressure was 108 systolic and 58 diastolic.



After removal to the ward, he was placed in an oxygen tent. A Levine tube was passed into the stomach and connected to a constant



FIG. 1. Diagram illustrating the course of the missile through the peritoneal cavity and the organs involved.

suction apparatus. An additional 500 cc. of citrated whole blood and two units (500 cc.) of plasma were given during the day following operation. A blood sulfanilamide level taken twelve hours after operation showed only a trace (less than 1.0 mg. per cent). Accordingly he was given intravenously 5 Gm. of sodium sulfadiazine in distilled water. His pulse rate varied from 124 to 160 during the day. Although his temperature was only 101.0°F. by rectum, he appeared extremely toxic and was irrational most of the time. Penicillin, at that time available only in very limited quantities, was started eighteen hours after operation, 12,500 units being given intramuscularly every two hours.

The condition of the patient improved considerably during the second postoperative day. He appeared much less toxic and there was a slowing of the pulse rate. A blood sulfanilamide level taken thirty-six hours after operation was reported as 20.6 mg. per cent. The plasma protein level was 6.75 per cent. The penicillin dosage was reduced to 8,750 units every two hours. An adequate fluid intake was provided

by the administration of glucose and saline, and glucose and distilled water intravenously. Thiamin chloride and vitamin c (cenolate), 1.0 cc. of each, were given intramuscularly daily. There was no abdominal distention. The continuous suction functioned efficiently. About 1,000 cc. of drainage were returned in a twenty-four hour period.

By the third postoperative day all signs indicated continued improvement. He was irrational only at rare intervals. Peristalsis could be heard on abdominal auscultation. He was started on two ounces of water an hour. The constant suction tube was left in place but was clamped off for several hours at a time with no ill effects. He was again given 500 cc. of whole citrated blood. The blood sulfadiazine level was 7.8 mg. per cent and he was given intravenously another 5 Gm. of sodium sulfadiazine. The pulse showed further improvement. He remained out of the oxygen tent for several hours. He continued to gain during the next several days. The colostomy began functioning ninety-six hours after operation. He was placed on a semi-soft diet on the tenth postoperative day.

The penicillin dosage was gradually reduced and discontinued entirely after the fourth postoperative day. He had received a total of 300,000 units during that time. No sulfonamide was administered on the third postoperative day, but with this exception he received 5 Gm. of sodium sulfadiazine intravenously from the second to the twelfth days inclusive. From the thirteenth to the eighteenth days inclusive he received 1 Gm. of sulfadiazine orally four times daily. The blood sulfonamide level following the peak of 20.6 varied from 7.8 on the fourth to 1.9 on the ninth, and 4.3 mg. per cent on the eighteenth postoperative day. (Fig. 2.)

The leucocyte count was followed at two-day intervals. Following a low of 6,000 on the fifth postoperative day, there was a rise to 14,000 on the twelfth postoperative day. By the nineteenth postoperative day, it had fallen to 4,000 with 68 per cent polymorphonuclear cells. No sulfonamide was administered after the eighteenth postoperative day. Two days later his leucocyte count had fallen to 1,200 with 99 per cent lymphocytes. The erythrocyte count was 2,800,000 and the hemoglobin 85 per cent.

He again appeared critically ill. A diagnosis of agranulocytosis secondary to the administra-



he began to complain of considerable dysuria and his urine, heretofore normal, became grossly bloody. The question immediately arose

Closure of the colostomy was done under sodium pentothal anesthesia on the eighty-second day following the original injury.



FIG. 3. Cystogram showing reflux of the opaque media up each ureter and into the kidney pelvis.



FIG. 4. Cystogram taken two months later showing normal bladder and no demonstrable reflux up either ureter.

as to the possibility of a beginning vesicorectal fistula. A fecal odor to the urine was not noted and the patient denied the passage of any gas through the urethra. The urine continued to be grossly bloody, but cultures were sterile. Bleeding and clotting times were normal.

The patient volunteered the information that when he urinated his "bladder didn't seem to contract like it did before his injury but just folded up."

Urological consultation was secured and cystoscopy showed a loss of bladder tone with marked redundancy of the bladder mucosa. No evidence of a vesicorectal fistula was seen. A cystogram was taken and revealed a dilated bladder with a reflux of the opaque media up each ureter and into the kidney pelvis. (Fig. 3.)

The ureters were somewhat dilated. In the opinion of the urologist, this condition represented a neurogenic bladder, resulting from injury to the sacral plexus. It was believed that the bleeding was due to congestion of the redundant bladder mucosa. The patient was encouraged to void frequently. The urine remained uninfected and the hematuria gradually subsided.

Sulfanilamide was not used in the wound, which healed solidly and rapidly without incident. The convalescence from this point on was uneventful. A cystogram was repeated by the urological service two months after the original attack of hematuria, and a series of cystometric readings were taken. The residual urine was found to be less than 20 cc. and the study indicated that the bladder was regaining normal tone. There was no reflux of the opaque media up either ureter. (Fig. 4.)

At the time of his discharge from the hospital, he was fully ambulant. He had gained steadily in weight and was feeling and looking very well. He was returned to the mainland for sick leave, following which it appeared that he would be able to return to full duty.

#### COMMENT

The continuance of the sulfonamide therapy in this instance may appear to have been unnecessarily prolonged. It should be pointed out that the fecal contamination was extremely widespread, and

the subsequent peritonitis very severe. The continuation was dictated, in our opinion, in light of past experiences in which a number of cases of apparently "recovered" peritonitis developed residual abscesses following the early withdrawal of the drug.

The absence of pyogenic complications during and following the agranulocytosis may have been attributable to the relatively brief duration of this condition. On the other hand, the agranulocytosis, although of brief duration, was of great severity and the absence of pyogenic sequelae is noteworthy.

There are two schools of thought in regard to therapy in agranulocytosis due to drug sensitivity. The first is expressed by Dameshek:<sup>1</sup> "If the bone marrow leucocytes are not irretrievably damaged, the patient will recover; otherwise the effects of therapy in a given case are very dubious." The second is expressed by Jackson<sup>2,3</sup> who has stated: "In seventy-two personally collected cases of extreme agranulocytosis (without anemia of moment) due to sulfonamide compounds or other drugs, recovery occurred in but 30 per cent of these in which withdrawal of the drug was the only measure taken. In twenty-six similar cases in which the drug was withdrawn and adequate amounts of pentnucleotide (40 cc. daily) were given, recovery occurred in

66 per cent. The series is small, but the results are suggestive. In any event, daily leucocyte and differential counts should be done on all cases suspected of having agranulocytosis, and energetic measures should be taken immediately after the diagnosis is established."

We chose to treat this case "energetically." In addition to stopping the drug, transfusions, liver extract, and pentnucleotide were employed. For the purpose of suppressing pyogenic infection pending the resumption of normal bone marrow activity, we believed that penicillin on theoretical grounds should be included in the energetic measures employed in the management of this case. There is some evidence for the belief that it was of definite benefit. The inclusion of this drug among the "energetic" measures to be employed in the treatment of agranulocytosis is recommended pending further evaluation of the many factors involved in this condition.

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# SUBMUCOUS LIPOMAS OF COLON WITH SPECIAL REFERENCE TO ACUTE AND CHRONIC INTUSSUSCEPTION

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OUR interest in this subject was aroused by a patient who recently presented herself for treatment. In previous statistical reports such as that of Stetten, in 1909, the compilations dealt with submucous lipomas involving all parts of the gastrointestinal tract. Pemberton and McCormack presented a comprehensive report on this condition in the *Journal of Surgery* in 1937. In 1941, Gault and Kaplan presented a paper dealing with submucous lipomas confined to the colon and associated with intussusception, based on a compilation of 127 previously reported patients, and one report by the authors.

Lipomas involving the bowel occur as subserous and submucous tumors, the latter being the more frequent; and it is with this latter group that we shall concern ourselves here. This condition is considered relatively rare, as is attested to by Staemmler who, in 17,000 consecutive autopsies, found only nine lipomas involving the gastrointestinal tract, an incidence of 0.05 per cent; and by Comfort who found only twenty-four tumors out of 3,924 consecutive autopsies at the Mayo Clinic (0.061 per cent). However, in view of the fact that in a large number of instances the tumor may be entirely asymptomatic (11.6 per cent), we agree with Hellstrom that this condition is far more prevalent than the literature would lead us to believe.

**PATHOLOGY.** Submucous lipomas belong in the category of true lipomas, and as far as can be ascertained, are never congenital in origin. The tumor is, in the vast majority of instances, polypoid, well circumscribed and encapsulated, either sessile or pedunculated, and usually occurs

singly, although cases of multiple lipomas have been reported. The tumor shows no tendency to assume malignant propensities, although it is prone to undergo a variety of intrinsic alterations such as hemorrhage, cystic degeneration, inflammatory changes or necrosis. The mucous membrane covering the tumor is usually atrophied and scarred, although it may be hypertrophic. Instances have been reported in which the mucosa had completely sloughed off over the growth. The tumor originates from the fat cells in the connective tissue stroma of the intestinal submucosa.

Submucous lipomas are slightly less frequent than adenomatous polyps, but in comparison to carcinoma they are extremely rare.

**Symptomatology.** In many instances the condition is asymptomatic, particularly when tumors are small (11.6 per cent). Large tumors, however, are always associated with symptoms. Depending upon the character and size of the growth, and the condition of the bowel wall harboring it, the presenting symptoms may be chronic or acute.

In chronic cases the patient may complain of vague abdominal pains, intermittent or continuous. At times the pain may be colicky or diffuse, and frequently localized to the site of the tumor, where it may be mistaken for other intra-abdominal disorders such as cholecystitis or appendicitis. Constipation is an outstanding symptom, and is often associated with diarrhea. When associated with partial invagination of the involved portion, and when the lumen of the bowel is materially reduced, chronic obstipation may occur. Stools frequently contain mucus, blood or pus,

or all three, depending upon the degree of degeneration of the tumor. Large tumors may occasionally be felt through the ab-

spontaneously and went on to eventual recovery. The remaining patients developed acute symptoms and required sur-

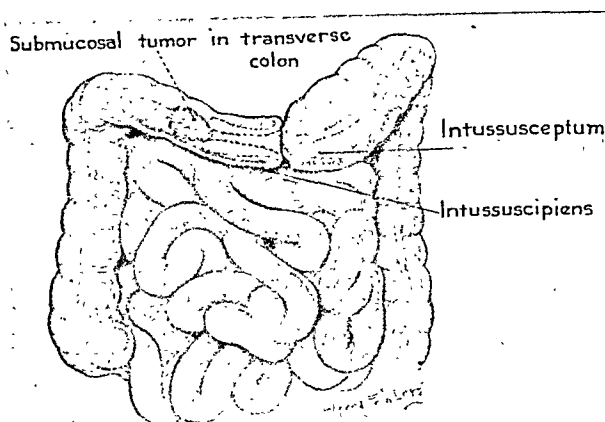


FIG. 1. Schematic drawing showing relationship of submucosal lipoma to intussusception of transverse colon.

dominal wall, particularly in thin patients. When situated in the rectum they can almost always be detected on rectal digital examination, regardless of size.

Acute syndromes result from acute intestinal obstruction, due most frequently to intussusception and occasionally to complete obstruction from the tumor itself without intussusception. In Stetten's series, 43 per cent of the patients, not including those with rectal involvement, were associated with intussusception. In our series, 45 per cent were associated with intussusception. The tumor has always been found situated at the tip of the intussusception. Stetten found intussusception present fourteen times when the tumor involved the small intestine, and fifteen times when the colon was involved. In only two patients was the obstruction caused solely by the tumor (Bland-Sutton, Russell).

When the growth is situated in the rectum the patient usually complains of tenesmus and constipation. Blood and mucus are frequently found in the stool. Invariably a polypoid tumor can be felt on rectal examination. Stetten found seven such tumors in his series.

**Prognosis.** In our series, fourteen patients (11 per cent) expelled the tumor

gical intervention. In the latter group, the mortality rate was 11 per cent.

**Treatment.** In chronic cases in which the identity of the tumor can be established presurgically, the best treatment is colostomy with extirpation of the tumor. However, where the identity of the growth is uncertain, it is best to perform resection of the involved portion of the colon.

When acute, surgery is urgently indicated. Tumors unassociated with intussusception are best treated by colostomy with removal of the growths when their precise identity is known before operation. When intussusception is present, it should be reduced whenever possible, and the tumor removed after opening the bowel. In instances of irreducible intussusceptions, several procedures are available. The bowel may be opened and the intussusception removed at its base; or the entire involved portion may be resected and the continuity of the bowel restored by end-to-end or side-to-side anastomosis. An even safer operation is the exteriorization procedure of Mikulicz. However, when a patient's condition is such as to preclude radical surgery, simple enterostomy should be carried out proximal to the obstruction, and radical resection of the involved portion of bowel performed

at a later date when his condition has improved sufficiently to enable him to safely withstand such an ordeal.

A tentative diagnosis was made of acute appendicitis and operation advised.

Operation was performed on February 27,



FIG. 2. Photograph showing surface of tumor.

Rectal tumors are best treated by extirpation after manually reducing the invagination when present.

#### CASE REPORT

Mrs. R. K., aged sixty-five years, was seen in consultation on February 17, 1942. Her complaints were severe constipation and abdominal pain. She stated that she had had no bowel movement during the past four days, although she had noted several bouts of diarrhea during the previous month, occasionally associated with nausea and vomiting.

Family and past histories were irrelevant. There was no loss of weight.

Physical examination revealed a well developed, elderly female who appeared ill. The abdomen was soft but moderately tender, with positive rebound elicited over the right lower quadrant. Save for these findings, the physical examination was essentially negative. Blood count: red blood count, 4,240,000; white blood count, 12,000; polymorphonuclears 80 per cent; lymphocytes 19 per cent; eosinophiles 1 per cent.



FIG. 3. Photograph showing tumor bisected.

1942, by one of us (J. A. L.). Under spinal anesthesia the abdomen was opened through a four inch right rectus muscle splitting incision. The appendix was found uninvolved, but the terminal ilium, cecum, and ascending and proximal portions of the transverse colon were distended. The examining hand passed along the transverse colon disclosed a large mass involving the distal portion of the transverse colon and splenic flexure. The right rectus incision through which this exploration was carried out was closed in layers, and a second incision made through the left upper rectus muscle. This was extended outward along the left costal arch. The great omentum was drawn out of the abdomen, bringing the terminal portion of the transverse colon into view. It was immediately evident that we were dealing with an intussusception of this portion of the bowel. After reducing the intussusception by traction, a tumor about the size of a large peach was palpated within the bowel, which had apparently formed the apex of the intussuscepted portion of bowel. (Fig. 1.) The tumor-bearing portion of colon was easily drawn out of the abdomen. Both limbs of the adjacent colon were approximated for a distance of about three inches with two layers of fine Pagenstecher sutures, and the peritoneum was securely sewed around this loop, but no sutures were passed between the peritoneum and the intestinal wall (first-stage Mikulicz). The rest of the abdominal wall was closed in layers. A transfusion of 500 cc. of citrated blood was given the next morning.

Five days later the extruded portion of the transverse colon containing the tumor was resected with a carbolized knife.

On April 16, 1942, a typical Mikulicz closure of the colostomy was performed, and the patient made an uneventful recovery.

Barium enema roentgenograms carried out two months later showed no defect in the transverse colon at the site of the anastomosis.

**Pathological Report.** "Macroscopic: Specimen consists of a resected portion of colon measuring  $11 \times 7$  cm. The serosal surface is dull, hemorrhagic and discolored. Projecting from the lumen of the distal edge there is a plum-sized polypoid mass measuring  $4.5 \times 5 \times 3.5$  cm. This projects into the lumen and beyond the distal edge. Its surface is hemorrhagic and discolored in some areas and pale and slightly yellowish in others. The surface is continuous with the mucosal lining of the lumen. The mucosal folds of the internal mucosal lining above the site of the polypoid mass show exaggerated thickenings which become entirely smooth over the mass, (Fig. 2.) On section the mass itself seems to be well localized and encapsulated. It consists of typical lobulated adult fatty tissue showing no unusual features. It is situated within the submucosa. Six cm. of the gut are present above the mass and 0.4 cm. of mucosa are present beyond the mass in some areas. In other areas the resection has been carried out at the point of projection of the mass above the distal mucosa. The wall of the gut proximal to the mass is hypertrophic. The contents of the mass do not penetrate its capsule. (Fig. 3.)

"Microscopic: The polypoid mass is covered by a layer of mucosa containing regular mucosal glands lined by regular columnar and cuboidal cells. There is slight fibrosis and scattered round cell infiltration of the mucosal stroma. The subjacent submucosa consists of dense collagenous fibrous tissue which forms the capsule of the mass noted in the gross. The latter consists of typical adult adipose tissue showing no unusual features. The nuclei of the fat cells are small and flat. The cytoplasm is clear. There is no penetration of the capsule by the enclosed fatty tissue. Sections through the adjacent gut wall show edema, interstitial hemorrhage and leukocytic and round cell infiltration, especially in the subserosal layer. In some areas within the submucosa of the gut wall in some distance from the tumor mass there are numerous scattered large fat cells of the adult type. In places these fat cells are present in aggregations which have no special capsule. There is fatty infiltration by regular adult fat cells within the subserosal layer.

"Diagnosis: (1) polypoid submucosal lipoma of colon; (2) fatty deposition of adjacent submucosa; (3) acute inflammation of adjacent gut."

#### CONCLUSIONS

1. Lipomas of the colon occur as subserous and submucous tumors.

2. Submucous lipomas are rare, are considered true lipomas, are never congenital in origin, and never undergo malignant changes.

3. When small, these tumors are frequently asymptomatic. Constipation and colicky abdominal pain are frequent symptoms in the larger tumors. Obstipation and signs of acute intestinal obstruction make up the syndrome in patients with acute intussusception.

4. Intussusception was found in 45 per cent of the reported patients, and the tumor has always been found at the tip of the intussusception.

5. In 11 per cent of the reported cases the tumor was spontaneously expelled.

6. Colostomy and extirpation of the tumor is the procedure of choice in which the identity of the tumor can be established prior to operation. Where identity is uncertain, the best treatment is segmental resection of the affected portion of bowel.

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# FISTULA OF SUBMAXILLARY GLAND FOLLOWING EXCISION OF THYROGLOSSAL CYST

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THE complete removal of thyroglossal cysts, sinuses or fistulas remains a surgical problem in spite of the pronounced improvement in the treatment of these conditions following the general adoption of the operative procedure as described by Sistrunk<sup>16</sup> in 1928. The percentage of cures in any series will depend upon the degree of thoroughness of the operator in removing all epithelial remains of the thyroglossal tract. That a meticulous dissection is the chief factor in obtaining a cure is noted in the report of Pemberton and Stalker<sup>14</sup> on 261 operative cases from 1920 to 1938 at the Mayo Clinic with only four recurrences, (1.5 per cent) although 166 or 63.6 per cent had had, elsewhere, from one to ten unsuccessful operations. Other favorable reports include those of Clute and Cattell<sup>4</sup> who had no recurrences among fifty-eight cases and Gross and Connerley<sup>8</sup> with no recurrences among ninety-one cases.

In the diagnosis of a thyroglossal cyst the factor emphasized by most authors has been the midline, or near the midline location of the tumor usually between the thyroid cartilage and the hyoid bone. That the tumor of a thyroglossal cyst may be found away from the midline is noted in a case reported by Fraser<sup>6</sup> who found a cyst left of the midline in the hyoid bone and who believed that a portion of the thyroglossal tract branched at the hyoid bone into several buds which deviated from the midline. Parsons,<sup>13</sup> in lipiodol studies of a thyroglossal fistula with submental opening, noted a tract running to the hyoid bone and thence to the foramen cecum but with several branching processes just above the hyoid bone. Russell<sup>15</sup> has reported a case in which a thyroglossal cyst was

located beneath the right submaxillary gland and another case in which a midline cyst proved to be a retention cyst of the right submaxillary gland. No other reports of the occurrence of retention cysts of the submaxillary gland in the midline have been noted in the reviews of cysts, sinuses or fistulas of the neck.<sup>1-18</sup> McClintock<sup>10</sup> states that it is almost impossible to distinguish a dermoid or a sebaceous cyst in appropriate places from a cyst of the thyroglossal tract and cites a case in which a colloid adenoma of the thyroid and another in which a sebaceous cyst were diagnosed as thyroglossal cysts. Lipomas, ranulas, hemangiomas and discrete tuberculous glands in the submental area have been mentioned as conditions to be considered in the differential diagnosis. Clute and Cattell<sup>4</sup> are of the opinion that there are few lesions to confuse with thyroglossal cysts and that the diagnosis depends upon movement with deglutition, intimacy with the hyoid bone and midline location.

In reviewing the literature on thyroglossal cysts, sinuses or fistulas no case has been encountered in which a fistula of the submaxillary gland followed the excision of a thyroglossal cyst or sinus. In the following case report an operation was performed to remove a thyroglossal cyst on September 3, 1941, and was followed by another operation on September 28, 1942, to excise a thyroglossal sinus and by still another operation on July 7, 1943, for excision of a thyroglossal sinus. With the latter operation the excision of the left submaxillary gland resulted in the cure of a condition that had been diagnosed repeatedly as a thyroglossal sinus.

## CASE REPORT

A white male, age twenty-seven, was admitted to the Station Hospital, on June 30, 1943, for treatment of a persistent draining

with no members of immediate family dead and no record of any familial diseases.

The patient was a well developed and nourished white male, age twenty-seven, 70 inches

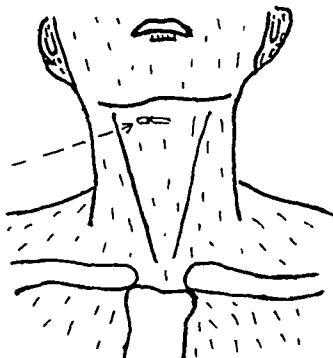


FIG. 1. Fistula from left submaxillary gland opening below hyoid bone and to right of midline.

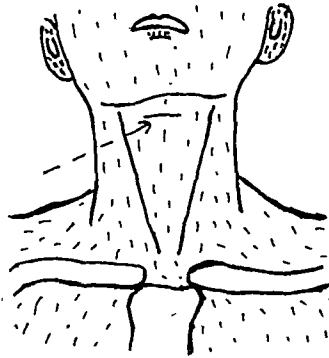


FIG. 2. Operative scar below hyoid bone following excision of submaxillary gland and fistula.

sinus of the neck. In July, 1941, he had noted a swelling beneath the chin and in the midline of the neck and was operated upon September 3, 1941, in a hospital in Massachusetts and discharged as cured nine days later. An abstract of his clinical record which was obtained from that hospital showed a preoperative diagnosis of thyroglossal cyst and following preoperative injection of methylene blue excision of the cyst by the Sistrunk method. The preoperative diagnosis was confirmed at operation and by subsequent tissue examination. Three weeks after discharge from the hospital the patient developed a draining sinus in the midline of the neck through the old surgical scar.

About one year later, on September 28, 1942, he was operated upon in a hospital in Florida where a preoperative diagnosis of thyroglossal sinus was made and another Sistrunk operation was done after injection of methylene blue into the sinus tract. The preoperative diagnosis was confirmed at operation and the patient was discharged as cured on October 3, 1942. Again, about three weeks after discharge from the hospital, the patient developed a draining sinus in the operative scar just to the right of the midline from which there has been daily spontaneous drainage. The patient had had measles, mumps, whooping cough and chicken-pox in early childhood and no other illnesses, and no operations other than those mentioned above and no injuries. His father, mother, two brothers and three sisters were living and well

(178 cm.) high and weighing 170 pounds (77 Kg.). On admission his temperature was 97.8°F., pulse 74, respiration 18 and blood pressure 126/70. There was a draining sinus on the neck midway between the hyoid bone and the thyroid cartilage, about 1 cm. to the right of the midline and in the center of a 6 cm. transverse scar just below the hyoid bone. An odorless discharge of milky water appearance and consistency was present about the sinus opening and a dense subcutaneous band of tissue extending upward and attached to the center of the hyoid bone was palpable and followed the movements of deglutition. The physical examination was otherwise negative and a preoperative diagnosis of thyroglossal sinus was made. No methylene blue or other solution was injected into the sinus tract prior to operation as it was believed that injection of methylene blue at previous operations was done under too much pressure and that subsequent discoloration of the adjacent tissues had interfered with the proper determination of how much discolored tissue should be removed with the result that a portion of the thyroglossal tract was not excised.

Operation under closed nitrous oxide, oxygen and ether anesthesia was performed on July 7, 1943. The old scar was excised about the sinus opening and the incision was extended to the left 2 cm. to equalize both sides of the transverse incision. An indurated band of tissue was followed from the sinus opening to the center

of the hyoid bone which it appeared to penetrate but which was found to be only closely attached to the anterior surface from whence it continued upward and to the left to end in the substance of the left submaxillary gland. The submaxillary gland with the attached band of indurated tissue was removed intact and a fine rubber dam drain was placed in the submaxillary fossa. Number 80 cotton was used for ligatures and for closure. The drain was removed in eighteen hours and the skin sutures in forty-eight hours. The pathological report on the tissues removed was as follows:

Specimen consists of an oval shaped, lobulated, moderately firm, light pink mass measuring 4 by 2 by 2 cm. Extending from one margin is a sinus tract measuring 3 mm. in diameter and 5.5 cm. in length which leads to a small elliptical shaped portion of skin. The cut surface is yellowish pink and lobulated. Sections of the mass show well preserved glandular acini supported by a scanty fibrous stroma. Sections of the fistulous tract show a wall of partially hyalinized collagen within which are small areas of extravasated red blood cells. There is a small central lumen devoid of epithelial lining. Pathologic diagnosis: Submaxillary fistula.

The patient was discharged from the hospital twenty-four days after operation. Three months later there was a well healed surgical scar and there had been no recurrent drainage. Following operation the additional history was obtained that the drainage had always been more profuse while eating. It is believed that the initial lesion in this patient was a thyroglossal cyst with lateral branches from the thyroglossal tract in the area of the hyoid bone and that in the dissection of the tract the left submaxillary gland was traumatized because of efforts to remove all adjacent tissues discolored with methylene blue. In the second operation it is believed that methylene blue discoloration of tissues adjacent to the sinus tract was responsible for failure to follow the tract to the submaxillary gland.

#### SUMMARY

A case of external submaxillary gland fistula opening through the midline of the neck anteriorly, midway between the thyroid cartilage and hyoid bone and following operations for excision of thyro-

glossal cyst and excision of thyroglossal sinus, is reported. Cure was obtained by removing the fistulous tract along with the left submaxillary gland through an incision as recommended by Sistrunk for the excision of a thyroglossal sinus. The occurrence of the submaxillary gland fistula is believed to have been due to branching of the thyroglossal tract at or near the hyoid bone and to operative trauma to the left submaxillary gland as a result of discoloration of normal tissue adjacent to the thyroglossal tract by the use of methylene blue for injection into the cyst prior to the initial operation.

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# LYMPHOSARCOMA OF THE SMALL INTESTINE\*

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AN account of a lymphosarcoma of the small intestine, occurring in a boy seven years of age, was published in the *American Journal of Surgery* for January, 1935, by Herman Charache. Full clinical and pathological details accompanied a description of the operative treatment, and 375 similar cases found in the literature were also cited. In the March, 1943, issue of the same journal, Charache made an additional report, with the sub-title "Follow-up of Nine Years." The patient had been repeatedly examined at the Brooklyn Cancer Institute, but neither recurrence nor metastasis had ever been found. The boy was "sixteen years old, well developed, attending school, and has no symptoms." Charache concludes: "Of 404 cases of lymphosarcoma of the intestines reported in the literature, 103 had careful follow-ups. Of these, only fourteen survived for five years or more (13.6 per cent). Eight patients lived from seven to eleven years. The average duration of life was 16.7 months."

We cannot tell whether the 404 cases included that which Ritter and Shaffer reported in March, 1942, just a year previous to Charache's second report. Their patient was a man of fifty-five years, from whom "a tumor of the upper ileum" had been removed in August, 1936. The pathological report had been "malignant lymphoma of the ileum." When last seen on November 3, 1941, "the patient was in extremely good condition and free from all complaints . . . he works every day and does not observe any dietary routine." He had gained fifty-eight pounds since the operation.

Though Ritter and Shaffer state that "lymphosarcoma of the intestinal tract

is not a rare disease," no other writers (including Ewing, Stout and several other distinguished pathologists) agree with them. In the abundant literature, which is in itself testimony to the rarity of the condition, because when cases are seen but seldom, those that do come under observation are usually promptly reported, one invariably finds the statement that the disease is seldom encountered. In Ritter's service at the New York Post-Graduate Hospital, during a twelve-year period eleven cases of lymphosarcoma of the intestinal tract were seen. At the beginning of the present century, Libman could find but fifty-nine authenticated instances in all previous literature, and when Menne and his co-workers again reviewed it more than forty years later they found no more than 376 cases, only one of which had been seen in their own service at the University of Oregon Medical School where more than 38,000 pathological examinations had been made. Oddly enough, they very shortly saw another case, which moved them to make a full report upon this "rare" condition.

Because we agree with the majority that the condition is rare, and likewise because so few survivals for any length of time are noted in any of the records, we believed it would be of value and interest to report a case in which the patient was operated upon by the senior author in March, 1941. Though males greatly predominate among the victims of this disease, our patient is a female; though Usher and Dixon quote a number of writers as having "found lymphosarcoma of the intestines to be more prevalent in the early decades of their patients' lives," reporting that most "were between the ages of twenty and forty years." Our patient was but eighteen

\* From the Third Surgical Service, Unity Hospital, Brooklyn, New York, Dr. Daniel MacAteer, Director.

years old. Although Sugarbaker and Carver found that lymphosarcoma of the small intestine gives a better prognosis than the same neoplasm located elsewhere in the body, Stout of Columbia University, dealing with ninety cases, came to the conclusion that "if the neoplasm manifests itself before the age of twenty, the chances of long survival are minute; they are greatest if the patient has passed his fortieth year." Yet our patient, now almost twenty-two years old, is a healthy young married woman who is pregnant at this writing.

Inasmuch as "the average duration of life was 16.7 months," we believe the following case to be worthy of a place in the literature:

#### CASE REPORT

C. A., a white girl, aged eighteen years, was admitted to Unity Hospital, March 29, 1941, with a history of having experienced a sudden sharp pain thirty-six hours before. The pain had been continuous since and was accompanied by nausea and vomiting. Questioning elicited that she had had, during the previous six months, occasional attacks of abdominal "cramps," which had become more severe with each recurrence, and that she had lost weight during this same period. The bowel movements had been irregular, with frequent attacks of diarrhea, though no blood nor mucus had been detected in the stool. The bowels had not moved at all for forty-eight hours previous to entrance, and an enema, given on admission, had returned clear.

On physical examination the patient appeared well nourished, but was acutely ill. All reflexes were normal, as were all physical findings, save those in the abdominal region. Though there was not much rigidity, the abdomen was distended and tender all over, and a hard movable mass, about the size of a grapefruit, could be palpated to the right of the umbilicus. This mass was slightly tender.

The blood count was as follows: red blood cells 3,270,000; white blood cells 13,400; differentials: polymorphonuclears 90 per cent; lymphocytes 10 per cent; hemoglobin 44 per cent.

The preoperative diagnosis was "intestinal obstruction," and the patient was prepared

for operation, glucose being administered intravenously, and gastric lavage given.

An upper right rectus incision revealed a straw-colored fluid in the peritoneal cavity, with a mass of enlarged glands matted with the small intestine, which lay about five feet from Treitz's ligament, and appeared to arise from the jejunum. Above this point the intestine was greatly distended, but below the mass it was collapsed. There were many large nodules in the mesentery supplying that portion of the bowel.

The procedure consisted in resection of a length of jejunum about eighteen inches long, which included the involved portion of the bowel as well as the glands in the mesentery. After joining the bowel by an end-to-end anastomosis, the abdomen was closed without drainage.

A transfusion of 400 cc. of citrated blood was given while the patient was still on the table; another transfusion was given two days after operation, and because she was anemic a third transfusion was thought necessary five days postoperatively. Convalescence was uneventful, and discharge took place April 12, 1941, two weeks after entrance.

The gross specimen measured 6 by 4 by 5 inches and consisted of a section of small intestine, matted together with mesentery and enlarged mesenteric glands.

Microscopically, it appeared that the entire histological structure of the section of intestine had been altered in the tumefaction, as this was composed of a diffuse growth of lymphocytic cells. These cells were irregular in size and shape, and stained unevenly; this irregular structure characterized many of the blood vessels. The reticulum was quite scant.

Pathologic diagnosis: Lymphosarcoma of the small intestine.

The advisability of giving deep x-ray therapy to the abdomen was considered, but was decided against because of the fear of sterilizing so young a patient. The wisdom of this decision was attested to at her last examination, January 20, 1945, when she was found in excellent health and four months pregnant.

Though several excellent reviews of the literature on lymphosarcoma of the small intestine are available, covering the period from 1900, when Libman's paper was published, it may not be out of order briefly to consider the general subject:

*Incidence.* Libman was the first to attempt to standardize the nomenclature of intestinal "sarcoma," and separate three cases in 1919, he designated the condition as "lymphoblastoma," and after a careful and often baffling search of the

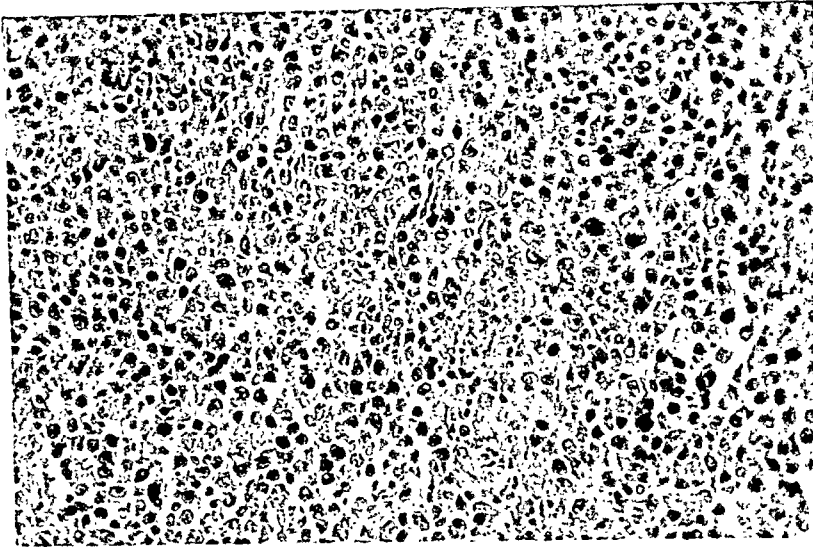


FIG. 1. Low power microphotograph; diffuse growth of lymphoid cells occupying the entire field—360 X.

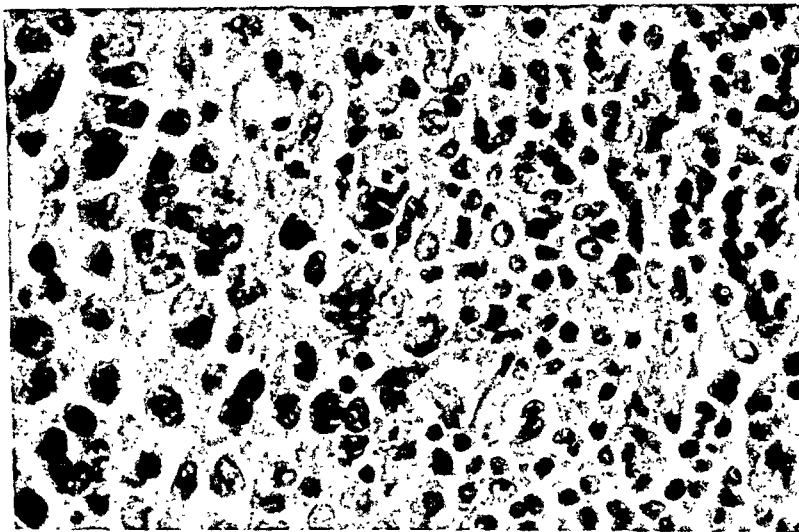


FIG. 2. High power microphotograph; this shows diffuse growth of lymphocytes, which vary in size, shape and staining characteristics—890 X.

lymphosarcoma, the most prevalent type in the small intestine, from other forms. Speese, who wrote in 1914, found thirty-four lymphosarcomas, out of ninety-nine cases of intestinal sarcoma investigated, but Müller, who wrote six years later, discovered but one among 102 sarcomatous neoplasms. When Graves reported his

literature, gave the incidence of "lymphosarcoma" as forty-eight out of 119 cases. Of more recent writers, Menne, as we have seen, could find but two among almost 40,000 pathological examinations in their own service, and records of 376 authenticated cases in all literature up to 1942. The next year, from the Mayo Clinic at

Rochester, Minnesota, Usher and Dixon quoted the figures of Ulman and Abeshouse, who collected 375 cases up to 1932, and added ten of what they termed "small round-cell sarcoma," and nine "reticulum-cell sarcoma," both types included under the general head "lymphosarcoma" of the jejunum and ileum. Thus the entire number of authenticated cases of lymphosarcoma of the small intestine is still below 400, warranting its continued classification as a "rare" disease.

*Part of Intestine Most Often Affected.* While our patient's lesion was in the jejunum, most authors agree that the ileum is the section of the intestine most often involved. Of recently reported cases, both those of Menne were in the terminal ileum at the ileocecal valve. The Mayo Clinic figures show that 38 per cent of all intestinal sarcomas are located in the jejunum and ileum. Ullman and Abeshouse's own patient had a lesion of the ileum, but among the 126 previous cases (of lymphosarcoma in both small and large intestines) there were: in the duodenum four; duodenum and jejunum one; jejunum seventeen; jejunum and ileum four; ileum alone thirty-six; ileocecal portion eight, and five records which merely stated "small intestines."

*Metastasis and Recurrence.* Inasmuch as our patient *did* have metastasis but *did not* for a five-year period, suffer recurrence, we have given especial attention to these points in our review. Of the fifty Mayo Clinic patients reported by Usher and Dixon, "All but two of the nineteen patients who had lymphosarcoma of the small bowel died of recurrence within a year." Of the entire series (which included lymphosarcoma of the cecum) "Metastasis was found to be present in 68 per cent."

These same authors remark that all the mesenteric lymph nodes examined, which numbered twenty-five, "were found to be malignantly involved," which led them to conclude that, "Apparently, all reticulum cell and small round cell

sarcomata metastasize early." Cheever thought that it is not so much free-cell metastasis as direct permeation, which spreads the disease into the regional lymph nodes, and that metastases, either regional or general, may also be carried by the circulation of either blood or lymph. The chances of survival after operation seem to be in inverse ratio to the amount and extent of the metastatic involvement, which makes our own case the more remarkable, inasmuch as extensive metastasis to the mesenteric nodes was present at operation.

*Diagnosis.* As regards diagnosis, or rather the symptoms and roentgen findings on which it is based, there is a wide divergence of opinion among writers both recent and remote. Yet there is one point upon which Libman in 1900 and those who wrote in 1943 are in perfect agreement: The diagnosis is never made before operation or autopsy. In most of the histories it is apparent that the lesion existed a long time without making the patient aware of its presence. The usually listed symptoms of "cancer of the bowel," such as blood in the stool, alternating diarrhea and constipation, colicky pain, are notably absent. The first indications of an intestinal lesion are those of obstruction which suddenly become acute and bring the patient under observation. The most common history is one of "vague" digestive disturbance covering a long period, but gradually increasing in severity.

As regards x-ray findings, in Usher and Dixon's nineteen cases, "roentgenograms were made of the small intestine ('stasis ray') and in each case the lesion was visualized." These authors claim, "The characteristic dilatation of the small intestine is well visualized by this method," and cite several other writers as having urged a more extended use of "stasis ray" as favoring earlier diagnosis of intestinal lymphosarcoma. Menne states that roentgen examination generally reveals residuum in the loops of the ileum, rigidity of the ileocecal valve, a filling

defect of the cecum, and distention and obstruction of the small intestine. In Benjamin and Christopher's patient, "Roentgen examination showed chronic partial small bowel obstruction of undetermined nature. . . . The physical examination was negative with the exception of visible peristalsis, distention of the upper abdomen, and marked borborygmus."

The only writer who vaunts the value of x-ray diagnosis is Chont who declares that, "Exact diagnosis can be made in many cases of lymphosarcoma by the motor meal. . . . In two of our three cases . . . roentgen examination was made and the origin of the tumor definitely located." He goes on to say, "Since all types of lymphosarcoma are definitely radiosensitive and respond to even small doses of radiation within a few days, this property can be used for diagnostic purposes by the 'radiation biopsy.' Applied to an abdominal mass of unknown nature, 200 r units of deep roentgen ray will produce a recognizable diminution within 72 hours, if the tumor is a lymphosarcoma." We have failed to find any reports of this diagnostic aid being used elsewhere.

*Treatment.* All patients save one of Chont's have been treated surgically, though many received postoperative x-ray. The value of radiation has not yet been established. Our patient has done well without it, yet one cannot generalize from a single instance. We must wait for more data before drawing any conclusions of value.

#### SUMMARY

A case of lymphosarcoma of the ileum, occurring in a girl aged eighteen years, is recorded, with a description of her con-

dition five years after operative removal of the tumor.

The case is compared with two others reported during the past decade, wherein the patients have survived for five years or more.

A summary of the literature on lymphosarcoma of the small intestine is included, with brief discussions of incidence, pathology, diagnosis, and treatment.

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# FETAL BONES PASSED IN THE FECES\*

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THE discharge of fetal bones by way of the intestinal tract is rarely encountered. During the period of pregnancy the fetus may come to lie in the abdominal cavity. This may be the result of a primary abdominal pregnancy, the expulsion of the fetus from the other sites of extra-uterine pregnancy, or extrusion from a ruptured uterus. Unless the fetus is removed it may undergo suppuration and the contents of the abscess may discharge into the bladder, intestines, vagina, or through the abdominal wall.<sup>1,2,3</sup>

The following case report describes the course of events leading up to and following the passage of fetal bones in the feces of a tuberculous patient subsequent to a therapeutic abortion:

## CASE REPORT

Mrs. F., a well nourished Italian housewife, aged twenty-six, was admitted to this Hospital on December 14, 1943, complaining of severe pain in the right lower quadrant of the abdomen of two weeks' duration. The temperature was 104.8°F., respirations 32, pulse 120 per minute.

The patient said she enjoyed good health until the age of seventeen when she became ill with tuberculosis of the lungs. Four years later, in 1939, the patient was admitted to this Hospital with pulmonary tuberculosis in the moderately advanced stage. Her progress was unsatisfactory and the left lung was collapsed by an extrapleural pneumothorax. She returned home in April, 1941, with the pulmonary disease apparently arrested.

The patient attended our out-patient department and several slight extensions of the disease in the lungs were noted but further sanatorium treatment was refused until she became acutely ill following a therapeutic abortion in December, 1943.

Mrs. F. has two children, aged seven and two years. Four months previous to the birth

of her first child an appendectomy was performed; recovery was uneventful. In September, 1941, a two months' pregnancy was interrupted without sequelae. In the Fall of 1942, the second child was born; following which there was a persistent, profuse, yellowish vaginal discharge, partly alleviated by douches. Menstruation, which began at the age of eleven years and was normal, returned six weeks after delivery. The last menstrual period occurred in August, 1943. In September, 1943, there was morning nausea and vomiting with vaginal bleeding for one day. On December 2nd, the patient entered a general hospital and a four-months' pregnancy was interrupted by a therapeutic abortion. The attending surgeon states that fetal parts and what appeared to be placental tissue were removed by curettage, and it was his impression that the uterus was empty when the operation was completed.

The day after the operation, the patient became feverish, her temperature was 101°F., and there were cramp-like pains and a tender mass in the right lower quadrant of the abdomen. On the same day a large amount of foul-smelling greenish material was expelled from the vaginal tract, and on the eighth post-operative day a second expulsion of similar material occurred. Two days later diarrhea was first noted and persisted for many weeks. On December 14th, the twelfth postoperative day, the patient was sent to us because of active pulmonary tuberculosis.

On admission, the patient was well nourished but appeared acutely ill. On examination, the lower portion of the abdomen was protuberant and exquisitely tender and rigid. There was no vaginal discharge; the cervix was patulous. The uterus, freely movable, lay somewhat to the right and extended to the region of the umbilicus. A soft indefinite mass was felt in the cul-de-sac. Under general anesthesia the cervix was dilated, and almost the full length of the curet could be introduced. No foreign material was recovered from the uterus, but for a few days after the operation there was a foul-smelling bloody discharge. The adminis-

\* From the New York State Hospital for Incipient Pulmonary Tuberculosis, Ray Brook, N. Y.

tration of pituitrin and ergotrate caused a marked diminution in the size of the uterus.

On the eighteenth postoperative day, the patient complained of discomfort and scratching in the rectum during a bowel movement. On examination of the feces a number of small bony particles were found. Radiographic interpretation by Dr. B. Zinn—probably fetal bones.

In the early part of January, more foul-smelling green pus was expelled from the vaginal tract. From this pus, *Bacillus coli* were recovered in almost pure culture.

The condition of the patient remained critical and an exploratory laparotomy was performed on April 29, 1944. Numerous firm pelvic adhesions were encountered and when separated a mass, the size of a lemon, was found lying posterior to the uterus. The abscess was incised and a teaspoonful of pus was removed. A drain was placed in the pelvis and the abdomen closed. The examination of the pus showed bony particles similar to those found in the feces.

At the present time, approximately fourteen months following the therapeutic abortion, the general condition of the patient is somewhat improved; the temperature ranges between 98.6°F. and 101°F. daily, and there is a fecal fistula of the abdominal wall. The outlook for the patient is uncertain.

The bony particles from the feces and from the pus were sent to Dr. George W. Corner, Director of the Carnegie Institution of Washington, Department of Embryology in Baltimore, who submitted the following information: The specimen from the feces consisted of one ilium, one fibula, two metacarpals with two

basal phalanges attached, cartilaginous head of one femur and cartilaginous head of another long bone, of a human fetus estimated to have been fifteen to seventeen weeks old. The specimen from the pus consisted of a clavicle, two mandibles and several membrane bones of the skull from a human fetus estimated to have been thirteen to fifteen weeks old. "I think the explanation of the apparent dissimilarity in the age of the two lots of fetal bones is simply that the method of determining the age by comparison with specimens of more or less accurately known age, cleared to show the bones, is not very exact. I am inclined to compromise the two estimates and say about fifteen weeks." Dr. Corner remarked that the case was most curious and interesting, and at his request the specimens were retained for the Carnegie Collection.

#### SUMMARY

In the case history here reported, bones of a fetus were passed in the feces, and found in the pus recovered at operation from an abscess located in the pelvis. The statement of the attending surgeon that fetal parts were removed on curettage would indicate that the pregnancy was intrauterine.

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# New Instruments

## IMPROVED NEEDLE HOLDER

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**E**volutionary upgrowth of surgical technic concomitantly effects a gradual weeding of the tools and thus retard further technical advance. Therefore, surgeons should be kept constantly informed of improved or entirely

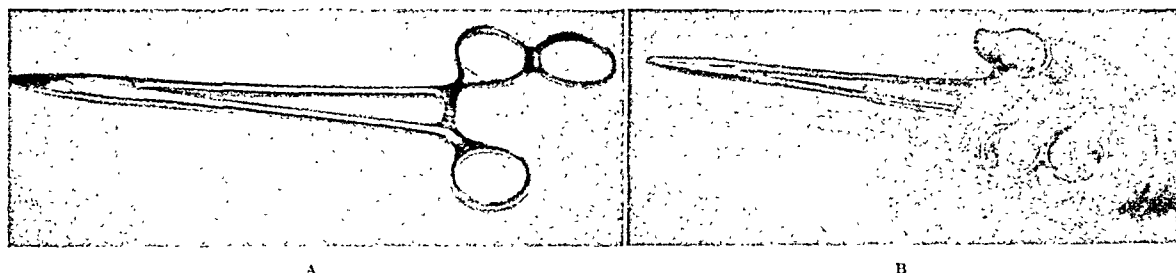


FIG. 1. A, the improved needle holder, embodying the principle developed by the author; B, the improved needle holder in correct surgical grasp.

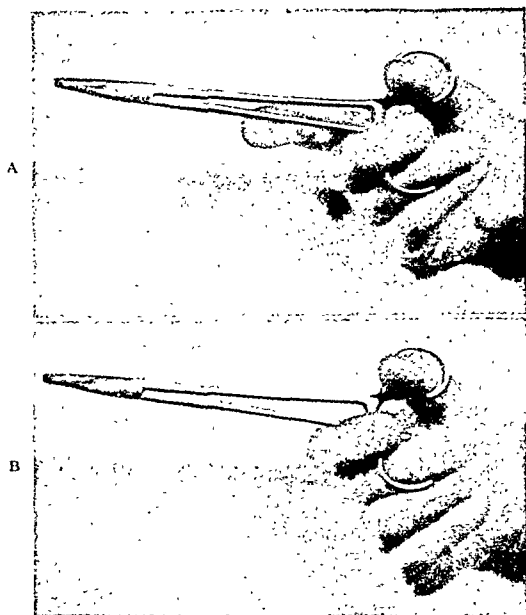


FIG. 2. A, the standard holder as held in one manner. The fifth finger is doing no work. B, the standard holder grasped in the alternative manner. The fourth and fifth fingers are idle.

of surgery. Extravagant standardization, however, may lead to instrumental stasis

new forms of instruments, so that their utilization may contribute to the pace of surgical progress.

The author's improved needle holder (Fig. 1A) obtains its superior features by providing for the utilization of all five fingers of the manipulating hand. This is effected by adding a single, highly important feature: a closed ring,\* which may be termed the accessory or secondary ring, is connected terminally to one of the regular rings, called the basic or primary rings, and this extension provides digital support. The instrument may be correctly grasped in the following manner: The thumb is inserted into the single ring, the fourth finger into the primary opening and the fifth finger into the secondary opening of the twin rings. The third finger is curled about the base of the stem, and the first finger loosely supports and directs the instrument head. (Fig. 1B.)

\* Other possibilities include the use of a closed supplementary ring attached to each of the two basic rings, the use of one or two open rings or blunted hooks, or a combination of these.

Grasping the standard needle holder, which may be done in either one of two ways, is a maneuver familiar to the

capacity, specifically corrects this point of deficiency.

*Advantages.* Through its improved de-

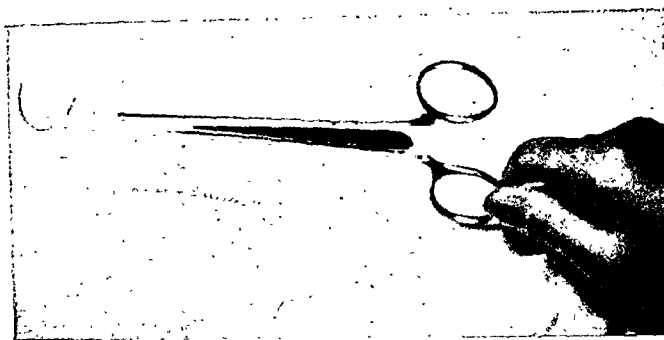


FIG. 3. Holding the instrument by its extension will increase the operating length of the needle holder.

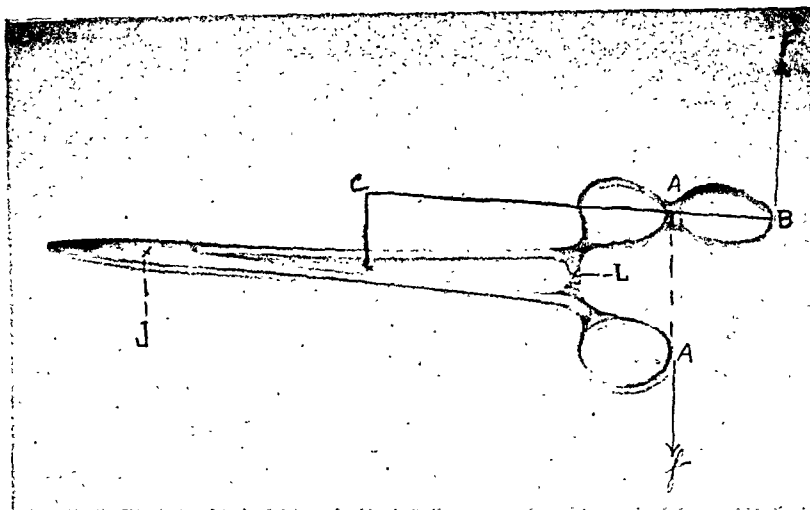


FIG. 4. As the needle holder changes during operation from a fixed or locked state to an open or mobile one, the fulcrum shifts between the joint of the instrument (J) and the locking mechanism (L). Since the distances involved are always constant and equal, a theoretical fulcrum may be considered to act at a point midway between these (c). The shorter arm will, then, act through the distance CA, and the longer arm through the distance CB. The increase in length of the arm CB is equivalent to the diameter AB of the supplementary ring. Digital pressure from the fifth finger increases force BF over that of counter force Af. Therefore, the mechanical advantage operating in this improved design to open the back will be an augmented one; and it will be regulated by the ratio of the lengths of the two arms. Thus, release of the locking mechanism is made easier.

surgeon and requires no elaboration. However it may be grasped, there are fingers which are idle, providing neither guidance nor support. Grasped in one way, the use of the fifth finger is lost. (Fig. 2A.) When held in the alternative manner, two fingers—the fourth and fifth—are not utilized. (Fig. 2B.) The new design, by promoting the use of the operating hand to its fullest

sign, this new holder offers four points of benefit to the surgeon:

1. A precise control and increased stability are made possible by appropriate pressure exerted at the terminus of the instrument by the small finger.

2. At the same time, pressure from the small finger complements the driving force of the needle holder, and thus creates a

reserve of power not attainable by the type of instrument now in use. This added strength aids in a general manner by promoting a freer injection of the needle, and specifically by facilitating propulsion of the needle through unusually dense, fibrous tissue.

3. The addition of an extra ring lengthens the holder at the discretion of the operator. (Fig. 3.) This is a particular advantage to the thoracic surgeon whose specialty often necessitates close work within the interior of the chest.

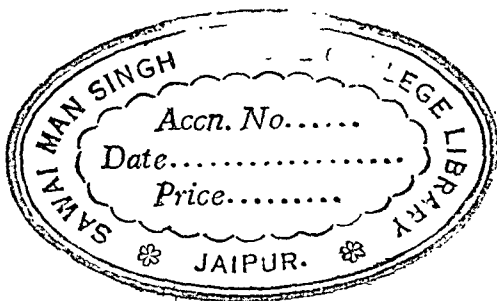
4. Of prime importance in this type of instrument, which requires constant opening and closing of its jaws, is the increased facility in the release of its locking mechanism. This is made possible through the factor of leverage inherent in the design. (Fig. 4.) Today's needle holders are provided with two arms of equal lengths. Extending one of its arms backward, as

in the new type, creates what is in effect a lever system. Applied to the new instrument, the physics of the system operates to produce a mechanical advantage which is considerable and definite by magnifying the ease in the release of the locking mechanism.

It is believed that once accustomed to the facilities of this improved instrument, surgeons would find it difficult to revert to the less efficient holder now in use.

#### SUMMARY

An improved needle holder is described. This new design permits the utilization of all the fingers of the hand operating the instrument, and gives a more thorough control and greater stability, an increased driving force, a lengthening of the holder at the discretion of the operator, and facility in the release of the locking system.



# ANAL RETRACTOR FOR USE IN ANORECTAL SURGERY

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GOOD exposure in all types of surgery often means the difference between a well planned and easily executed steps are mounted over the adjacent ends of the semi-anular members for locking them in end abutment with each other.

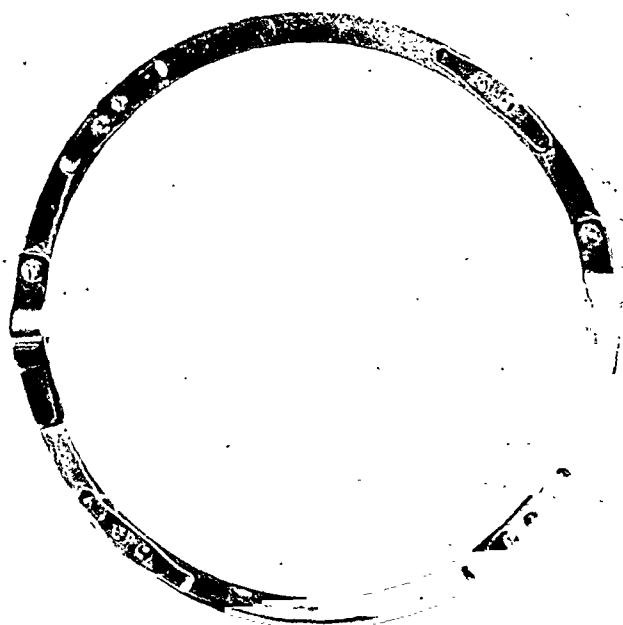


FIG. 1. Shows the circular anal retractor open and ready for use.

FIG. 2. Shows the circular anal retractor folded.

operation and a well planned but difficultly executed operation. This is especially true in operations on the anorectal region.

Hullsiek, in 1937, described a malleable steel ring, 9 inches in diameter with notches at the periphery, to be used in obtaining exposure in anorectal surgery.

A ring which I have devised, as shown in Figure 1, consists of a pair of semi-anular members having their ends in end abutment with each other and connected by hinges so as to be foldable in half. Anchor springs are mounted on the top faces of the semi-anular members. Rigid

The features of the anal retractor may be seen in Figures 1 and 2. The method of using the anal retractor is shown in Figure 3.

The patient is placed on the table in the prone position. The table is broken slightly and a length of 3 or 4 inch adhesive is applied to each buttock just opposite the anal verge, and traction made on the adhesive which is then fastened to the table. By using this position the surgeon is not hampered by having one leg on either side of him with very little room for an assistant, as in the lithotomy position

A black silk suture is placed in each of the four quadrants of the peri-anal region, passing through the skin only. If one desires

or external hemorrhoids. Before making traction on the silk sutures, the sphincter muscle is gently dilated. Traction is made on the black silk sutures, and the silk is slipped beneath the anchor spring of the circular anoscope and tied.

As can be seen in Figure 3, excellent exposure is obtained and one is able to perform the anorectal surgery without an assistant.

The features of the circular anoscope are: (1) It provides ideal exposure; (2) it can be used on any patient regardless of the size of the buttocks; (3) it obviates the necessity of one or two assistants; (4) it is small, just  $6\frac{1}{2}$  inches in diameter when the anoscope is opened; (5) when folded, the anoscope is compact and fits into a sterilizer very easily, and (6) it is sturdy when opened and locked.

The photographs were taken at the Meadowbrook Hospital, Hempstead, New York, through the courtesy of Dr. A. J. McRae, Superintendent of the Meadowbrook Hospital.

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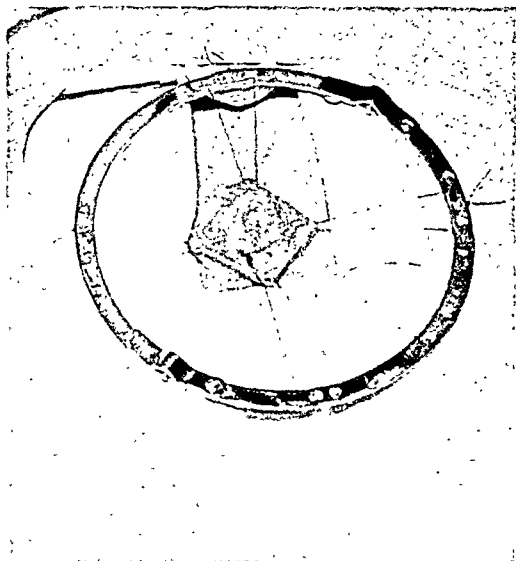


FIG. 3. Shows the circular anal retractor in use.

to remove the internal hemorrhoids separately, the silk can be placed through the skin tabs; or if one wishes to remove the external hemorrhoids or skin tabs in conjunction with the hemorrhoids, the silk may be placed just distal to the tabs

# DEVICE TO PROTECT THE PROJECTING END OF KIRSCHNER WIRES, STEINMANN'S PIN OR EXTERNAL FIXATION PINS\*

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THE increased use of skeletal traction and particularly external fixation in the treatment of fractures presents

The apparatus consists of a fiber collar approximately one-half inch in diameter and one-half inch long. This is cut from

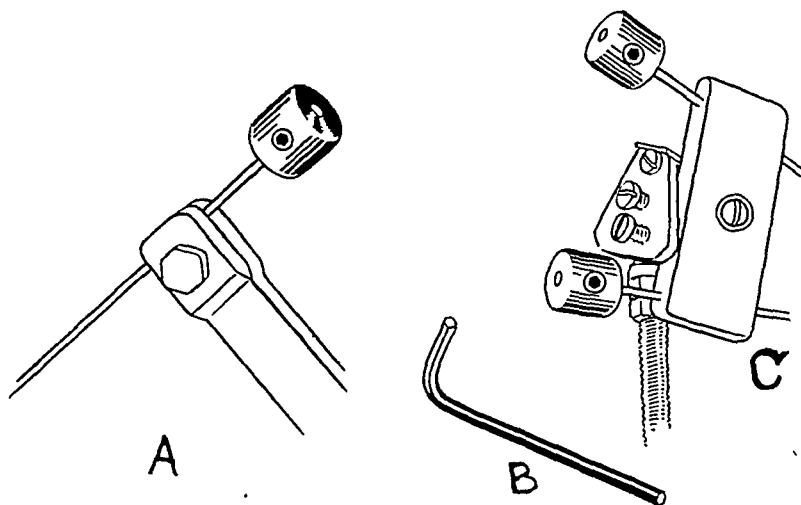


FIG. 1. A, the device in use with a Kirschner wire and bow; B, wrench for Allen screw; C, device in use on external fixation apparatus.

a real problem in the protection of the portions of the pin or wire which projects beyond the fixation device or bow. Frequently a cork is stuck on the end of the pin or wire and this is soon knocked off and the patient or his attendants are very apt to injure themselves by striking the projecting end of the pin or wire.

About seven years ago Mrs. W., a member of the family of one of us (L. W.) had a fractured leg which was reduced by Kirschner wires with a skeletal traction and was held in position by incorporating these wires in a plaster of paris cast in the usual fashion. The need for protection of the ends of wires became obvious and this device is our answer to the problem.

standard fiber stock. A hole is bored through the center of the stock; then the ends are dressed with a file and finished off with emory cloth. A hole is bored with a No. 25 drill and tapped to size 10 by 24 threads at right angles to the previous opening made through the fiber parallel to its long axis. In this hole a 10 by 24 Allen set screw is inserted and run down to impinge on a wire or pin and cover its projecting pointed end. (Fig. 1.) The size of the hole in the collar can be varied to fit the screw or pin.

We have been using this device for about seven years and it is eminently satisfactory.

\* From the Caylor-Nickel Clinic, Bluffton, Indiana.



# STETHOSCOPE FOR DOCTORS WITH HEARING DEFECTS\*

LIEUT. COL. HARRY M. KIRSCHBAUM

MEDICAL CORPS, ARMY OF THE UNITED STATES

THERE has been a good deal of advance in hard-of-hearing aids in the past twenty years. Several of screw plug (2) to the hearing aid (3), and clipping the ear piece (4) to the top of an ordinary binaural stethoscope (5), heart

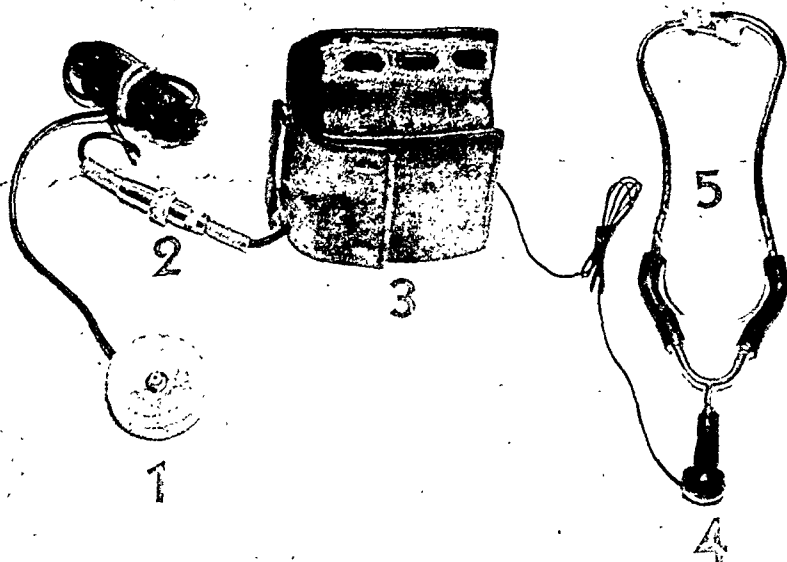


FIG. 1. Stethoscope assembled: author's microphone (1), description in paragraph 3. Stethoscope can also be used in the differentiation of murmurs.

these aids have been approved by the American Medical Association. There have been several attempts to make a portable stethoscope for doctors who are hard of hearing. One of these units is manufactured by the Western Electric but is quite large.

The device pictured shows a microphone of the author's invention as a part of his electrostethophone attached to an A.M.A. approved hearing aid which the doctor uses in ordinary conversation. The electrostethophone is a portable device to amplify fetal and adult heart sounds for recording on records, films or wire.

By connecting the microphone (1) at

sounds are transmitted to the ears when the microphone is placed over the precordium.

It is obvious that the tone and volume are controlled by the dials on the amplifying unit of the hearing aid. Murmurs are amplified and the fetal heart tones can be heard.

It is stated that people exposed to gunfire noise lose some hearing ability. After the war many of our doctors involved in air, land, or sea war may have diminished hearing. This device is, therefore, offered as a simple, practical pocket unit for the physician who is hard of hearing to be used in conjunction with his hearing aid.

\* Demonstrated before the Medical Section of the A. M. A., June, 1945.

# HISTORICAL ASPECTS OF CARDIAC RESUSCITATION

ROBERT F. BARBER, M.D.  
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AND CAPTAIN JOHN L. MADDEN  
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IN a review of the literature the earliest writings pertaining to cardiac resuscitation by manual massage are the experimental studies of the German physiologist, Schiff, in 1874. His first series of experiments were performed on dogs which were anesthetized with chloroform until the heart had ceased to beat. Subsequently and at varying intervals of time restoration of the normal beat was obtained by rhythmic manual massage of the exposed heart. This method succeeded where other measures failed. He was able to re-establish cardiac pulsation and respiratory movements up to eleven and one-half minutes after the heart had ceased to beat, although complete recovery did not ensue. His second series of experiments were performed with hearts which, after having been removed from the body, were frozen for varying and long intervals of time. Cardiac pulsations were then obtained by filling the heart with fluid and applying direct manual massage.

Fourteen years later (1898) the work of Schiff was confirmed by Tuffier and Hallion in France who performed a similar series of experiments on dogs.

Prus, in 1900, reported his results in a series of one hundred dogs in which cessation of the heart beat was obtained by the following methods: (1) chloroform, twenty-one; (2) asphyxiation, forty-four; (3) electrocution, thirty-five. In the dogs which were chloroformed the heart stopped beating at intervals of time varying from fifty seconds to twenty minutes, following the administration of the anesthetic. Upon cessation of the heart beat cardiac massage and artificial respiration were simultaneously performed at time intervals varying between fifty-five seconds and one hour. Restoration of a normal pulsation was obtained in sixteen within periods varying

from thirty seconds to twenty minutes. In the dogs asphyxiated, thirty-one recovered whereas only five of those electrocuted survived. In the same year (1900) Batelli confirmed the work of Prus and demonstrated that fibrillary twitchings of the heart muscle were frequently noted in the unsuccessful cases of cardiac massage. He was successful in overcoming these fibrillary contractions by the direct application to the heart of an alternating current of 240 volts.

In 1902, Kuliabko reported a series of experiments in which he removed the hearts of rabbits and placed them in an ice chest for forty-four hours. Subsequent to this period he was able to restore rhythmic cardiac pulsations by injecting Locke's solution into the coronary arteries. In a similar manner, in rabbits which have died from a disease process, he was able to restore the beat of the heart three or four days after death. The same author also reported the successful restoration of cardiac pulsations in the heart of a three-month old infant twenty hours after death. The pulsations in this case continued for over one hour.

The work of Kuliabko was supported by Velich who in 1903 placed the isolated heart of a dog in snow for six hours. Following this he was able to produce auricular and ventricular contractions by massage alone. He repeated this success in another heart which was placed in snow for eighteen hours and then frozen in salt solution for another two hours.

It was in the same year (1903) that Bourcart succeeded in restoring the normal cardiac rhythm in a dog by means of subdiaphragmatic massage of the heart. Massage was begun five minutes after cessation of the heart beat which occurred under chloroform anesthesia. The recovery

of the animal was complete after massage had been performed for three minutes.

During this period the work on cardiac resuscitation was not confined to the experimental laboratory. Niehaus, of Berne (1889), was the first to attempt resuscitation of the human heart by manual massage. This was unsuccessful and not reported. The first case reported was that of Tuffier and Hallion (1898). This, too, was unsuccessful.

Maag (1900) was able to re-establish cardiac pulsations and spontaneous respirations both of which persisted for eleven hours. This was the first report of a partial success.

Starling and Lane (1902) using the sub-diaphragmatic method of massage first reported a completely successful case of resuscitation of the human heart. Spontaneous respirations were not established until twelve minutes following the return of a normal cardiac rhythm. This success was preceded by that of Igelsbrud (1901), but it was not reported until three years later (1904).

Similarly Gray (1902), Cohen (1903), Sencert (1905), Conkling (1905), Smith (1905) and Ramsay (1906) reported cases in which complete recovery occurred following cardiac massage.

Green (1906) in an exhaustive review of the world literature was able to collect forty cases in which manual massage of the heart had been performed; thirty-six of these had been previously reported. In this series nine (22.5 per cent) complete recoveries were obtained and eight (20

per cent) partial successes. The latter included those cases in which the pulse and respiration were restored for variable periods of time but ultimately ended fatally.

In 1909, Von Cackovic collected forty-six cases. This report included three of his own with complete recoveries in two.

White (1909) added ten cases to the forty reported by Green. In ten (20 per cent) of these complete recovery was obtained and fourteen (28 per cent) were partially successful.

Bost made a collective review of the literature in 1918, and again in 1923, reporting sixty and seventy-five cases, respectively. Sixteen of seventy-five (21 per cent) recovered completely and twenty-three (30.6 per cent) were partially successful.

Lee and Downs (1924) added twenty-four cases to the seventy-five previously reported by Bost, including the presentation of a successful case of their own. This made a grand total of ninety-nine cases reported up to this time with complete recovery in twenty-five.

In an extensive review of the world literature from 1924 up to the present time we have been able to collect forty-four more cases with complete recoveries in twenty-three (52 per cent), and partial recoveries in sixteen (36 per cent). This brings the total number of cases reported to one hundred and forty-three, forty-eight (33 per cent) of which have been completely successful.



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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-fourth Year of Continuous Publication

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NEW SERIES VOL. LXX

NOVEMBER, 1945

NUMBER TWO

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## Editorial

### SURGERY AFTER THE WAR

IT is interesting to deliberate the tendency and fate of medicine and particularly of surgery after this war. No one can foretell the future; but if experience in the practice of surgery for many years offers a clue, I may be in a position to hazard a guess. During a period of almost sixty years I have witnessed a veritable revolution in the progress of the art and science of surgery.

In 1887, when I served as a Militaer-Elève (Med. Sgt.) in the Garnisons-Spital in Prague it was my duty to wax linen threads, the sutures with which my commanding officer, Stabsarzt Strejcek, who regarded himself a modern surgeon, sewed up all fresh wounds washing neither his hands nor the wound. Of course they suppurated, all wounds did; that was considered normal healing (*pus bonum et laudabile*). Then came the spectacular era of Lister's antiseptics, and as an "Operations-Zoegling" in Prof. Billroth's and Guessenbauer's clinic it was with wonder that we witnessed healing of wounds by primary union. Then followed the greatest advance of all, the development of the technic avoiding bacterial infection, the marvelous era of asepsis which enabled us to perform even the formerly dreaded laparotomy with impunity. Every part of the human anatomy, including brain

and spine and even the heart, was now successfully attacked by the surgeon. However, not only did operative technic show such progress but medical science and pathology as well became wide fields of study. The very fact that we could even for exploration open the abdomen and other parts *in vivo* without danger of infection afforded the surgeon the opportunity to observe pathologic changes in the living.

Medical history presents many illustrations of advance during periods of war. As early as the sixteenth century Ambrose Paré reintroduced the forgotten technic of ligation of blood vessels to stop bleeding in place of boiling oil or pitch. The Franco-Prussian war created many improvements in technic, among them the very important Essmarch tourniquet bandage. World War I found medicine and surgery, with a high standard Medical Corps, confronted with new problems which were met with startling new technics; and so it was that valuable contributions in plastic surgery were made. It will also be remembered that successful methods were developed to combat epidemic diseases—typhus, cholera and others—once rampant and now almost non-existent, a condition of immeasurable importance for an army. At the conclusion of the World War I began a feverish in-

terest and development of scientific activities, of international co-operation and exchange of methods. Doctors returned from their battle stations richly equipped with new experience and advanced methods. At this time the comparative values of standards of medicine and surgery could be observed in the family of nations.

Germany, hitherto judged as the most advanced nation scientifically, was superseded by others. The war had killed off her scientists and practicing surgeons in large numbers and those who were spared seemed to be affected with a sort of lethargy which did not allow them to continue the *scientific effort of former times*.

Instead of Germany, Great Britain and the United States developed a remarkable interest and enthusiasm for scientific work. This resulted in a predominance of progress in medicine in these countries and they became the most advanced stations of scientific life. All branches of biology were cultivated there, including medicine and surgery.

If we ask ourselves, what effect will this global war have on these two branches of science, we are convinced that Germany will be without any influence whatsoever; her scientists and surgeons are either dead or ethically and morally decadent owing to Hitler and his entourage. France, Austria and other European countries have suffered too much to have leisure and stability for science. It will remain, therefore, a privilege and pleasant duty of the victorious nations to carry and hold high the torch of science. Great Britain and Russia are capable, willing, even anxious to do it, and they certainly will when they have recovered from the wounds of the war; but the United States is the largest and the most promising country to come forward, free from ruin and devastation. We

are for the present the most advantageously situated country as far as equipment and facilities are concerned and the most favored with men of attainment, ability and interest for advancement in science.

Surgery will of course be benefited greatly from this progress. The fact that a large number of doctors, who in peacetimes were not engaged principally in surgery but were forced to operate in the field, gained experience and skill is important. They will like to improve their practice, choose a specialty and increase the number of practitioners. There is *room for all*. The war caused many casualties and unfortunately there will be many more. Mortality is low but there will be many thousands who will require operative or orthopedic treatment. New ideas, new and radically improved methods, new and better instruments will be invented. Already one new feature seems to be preeminently stressed the restoration of functional capability of the disabled soldier by daily practical exercises even during his initial stay at the hospital. Adding to these new methods there are discoveries of drugs like the sulfa-compounds, penicillin and a host of others and last but not least the use of blood serum plasma in emergencies. All these new experiences will have to be scientifically checked, which will require an enormous activity in research life, the establishment of numerous new institutions of medical research. In fact we read already of the intention and plans of the health authorities to establish a large number of new hospitals. A very busy scientific life will follow the war and unquestionably medicine and surgery will profit considerably.

CARL BECK, M.D.



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# Original Articles

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## PILONIDAL DISEASE\*

### MANAGEMENT OF CYSTS, SINUSES AND ABSCESES IN NAVAL PERSONNEL

COMDR. EMIL GRANET AND CAPTAIN L. KRAEBER FERGUSON

MEDICAL CORPS, UNITED STATES NAVAL RESERVE

AT our Naval Hospital 7.5 per cent of all operations on the surgical service in a recent period, were performed for the eradication of pilonidal inflammatory disease. According to the last available statistical report for the Medical Department of the United States Navy, 1941, pilonidal disease in the Navy and the Marine Corps accounted for 47,010 hospital sick days. From 1941 through 1943, the period coincident with the mobilization of our armed forces, thirty-two articles dealing with pilonidal disease were listed by the Index Medicus. These data indicate the magnitude of this problem, the adequate solution of which still challenges the medical corps of the Army and the Navy.

It is well established and universally accepted that the physical rigors and trauma associated with the military way of life ashore and afloat are direct factors in the activation of previously quiescent sacrococcygeal cysts and sinuses, to result eventually in pilonidal inflammatory disease and its sequelae. Study of recent publications leaves one with an accumulation of heterogeneous and conflicting information as to the best management of pilonidal disease, thereby affording little help to, and rather confusing the surgeon who is confronted with the problem of treating these patients.

It may be presumptuous to offer still another study on this well nigh exhausted

subject. However, in analyzing our rather extensive material, especially those cases recurrent after previous operative "cure," certain errors in treatment and post-operative care become glaringly evident. Profiting by our mistakes and those of our colleagues, treatment of our most recent patients has resulted in a very consistent minimum morbidity in attaining anatomical and clinical cures.

Most recent authors agree that effective curative treatment of pilonidal inflammatory disease requires surgery. Numerous surgical procedures have been described. Most recent writers favor excision en bloc followed by some form of primary closure. When successful, this procedure results in a wound which heals rapidly and with minimal scar tissue. A number of able surgeons favor some form of partial closure with drainage, thereby insuring against the all too frequent infection of the primarily closed wound and the overlong morbidity resulting when this complication ensues. Limitation of space precludes a critical evaluation of the various published methods of treatment. Failures of these have come to us in the form of recurrent sinuses or incompletely healed wounds despite prolonged treatment. Excellent recent papers on this subject are those of Kooistra, Buie, DePrizio, Lane and others,<sup>1-4</sup> a careful study of which is essential for a comprehensive knowledge of the subject. In this study we intend to

\* This article has been released for publication by the Division of Publications of the Bureau of Medicine and Surgery of the U. S. Navy. The opinions and views set forth in this article are those of the writers and are not to be considered as reflecting the policies of the Navy Department.

state our opinion as to the origin of pilonidal disease, to present a critical clinical analysis of a continuous series of 319 cases of inflammatory pilonidal disease treated surgically at our hospital and to describe the present method of treatment and management of these patients evolved from our experience.

Our problem—to return naval and marine personnel to full duty after one uninterrupted period of minimum hospitalization—is somewhat unique. In the case of acute pilonidal abscess for example, civilian and in some instances Army personnel stationed in camps with a post hospital are treated by simple incision and drainage. After a few days, they can be discharged to continue their work, or to light duty, returning at a later period—weeks or months—for surgical eradication of the disease in a now relatively quiescent state. Naval personnel, on the other hand, when transferred to hospital for treatment are expected to be returned to their ship or station with their wound completely healed and physically fit for full duty. Entirely quiescent lesions were not treated in this series as the present policy of the Navy Department, recently emphasized by Buie,<sup>2</sup> limits surgical treatment of pilonidal disease to symptomatic and inflammatory cases.

#### ETIOLOGY AND PATHOLOGICAL PHYSIOLOGY

The official Navy term, cyst teratoma, inflamed or quiescent, sacrococcygeal, clinically and anatomically adequately describes the condition. The coined term, pilonidal (pilus: hair; nidus: nest) has become recognized through usage even though it is a misnomer as these cysts sometimes do not contain hair. Kooistra<sup>1</sup> presents evidence regarding the origin of sacrococcygeal cysts and sinuses which to our mind concurs with clinical and pathological findings. In a study of forty human embryos, he found a remnant of the neurogenic medullary canal overlying the coccyx in all. In the larger embryos, this invariably assumed the character of a

cyst-like space lined by cells and as a rule, well separated from the skin. During the second half of fetal life these cyst-like structures were seen to undergo gradual atrophy becoming not only smaller in size, but also showing a tendency to be replaced by connective tissue. Kooistra also found evidence favoring a second theory. He found in some embryos, defects in the surface epithelium with marked irregularity, some showing actual invagination to form deep dimples. This latter description is in accord with the findings of Fox<sup>5</sup> in his exhaustive study of the subject.

According to these embryological studies the medullary (neurogenic) origin should be represented clinically by subcutaneous sacrococcygeal cysts which have no demonstrable sinus leading to the skin surface. On the other hand, pilonidal disease originating in the embryo by infolding of the epidermis occurs clinically as a sacrococcygeal dimple or sinus. Both anomalies frequently are concurrent so that contiguous cysts and sinuses are common clinically. Three types of chronic pilonidal disease seen clinically are the following: (1) Sacrococcygeal cyst, alone; (2) sacrococcygeal dimple or sinus, single or multiple, alone; (3) sacrococcygeal cyst adjacent to or communicating with one or more sinuses.

It is commonly accepted that hair found in pilonidal cysts and sinuses grows from the epithelial lining thereof. Our clinical and pathological observations refute this view. We have never found hair in a solitary pilonidal cyst (type 1 above). Hair was found only when the cyst was found to communicate with an adjacent sinus, in sinuses, and in deep dimples. Lane<sup>4</sup> carefully studied sections from forty-two cases of pilonidal disease. In the few cases in which fragments of epithelial tissue survived the destructive effects of infection, no sebaceous sweat glands or hair follicles could be found in any of his sections. We have yet to see undoubted evidence of hair follicle structure in sections taken through the wall of excised

pilonidal cysts. Sections through the hair itself lying free in the lumen or on the cyst wall are seen. Nor have published microphotographs presumably illustrating hair follicles in the wall of excised pilonidal cysts satisfied the histologic criteria of a true hair follicle. What has usually been illustrated is a cross-section through an actual hair. (Theis Fig. 3B—"H.")<sup>6</sup> Furthermore, if the neurogenic theory as to the origin of the solitary pilonidal cyst is accepted, it is difficult to explain in these the presence of epidermal structures such as hair follicles. At operation when strands of hair were found, they always lay free and unattached in the cyst or sinus cavity. It is our conviction that this hair is extraneous having its origin in the hair follicles of the skin of the natal fold adjacent to the sinus or dimple. Individual strands of hair originating in the external skin protrude and advance into the congenital sinus and even into the contiguous cyst. Eventually, through the trauma of constant friction between the skin surfaces in this region, some of the protruding hairs are broken off near their root and are retained in the sinus or cyst. Through years of accumulation and by constant moulding from external mechanical pressure, they eventually become compressed and kneaded into so-called hair "nests."

Normally quiescent pilonidal cysts and sinuses when exposed to oft repeated trauma eventually become painful, tender, and infected. The constant presence of pathogenic micro-organisms on the skin of the coccygeal region are prime etiological factors in the pathogenesis of these lesions. The rôle of trauma is illustrated by the universal habit of sailors who constantly sit on hard decks, knees drawn up, shoulders braced against the bulkhead and the entire weight of their bodies rolling back and forth on the sacrococcygeal area synchronous with the motion of the ship. Falls on deck and down ships' ladders are common and contribute to the marked prevalence of pilonidal inflammatory disease in the Navy.

#### CLINICAL MATERIAL

At our Naval Hospital in the twenty-month period from April, 1943, through November, 1944, 319 patients were operated upon for the eradication of pilonidal inflammatory disease. Incision of abscesses and other palliative measures were not included in this series. The earlier cases in this series, Group I, were assigned to the general surgical service and were treated by twenty-six different surgeons, inasmuch as changes in staff are frequently necessary in military hospitals. Diverse technics of operation, various suture materials and individual routines of postoperative management were employed in this series. These cases, therefore, afforded us a cross-section of the end results attained by the average surgeon in his treatment of inflammatory pilonidal disease. The average hospital time required for cure, as determined by complete epithelialization of the wound, was found to be prolonged in this group. It was apparent that some standardization of procedure was essential in order to obtain optimum reduction of healing time. Patients treated in the last eight-months period, Group II, were, therefore, assigned to one surgical ward under the care of one of us (G.). Standardization of treatment, to be described, resulted in substantially reduced sick days as compared to Group I.

Inasmuch as pilonidal inflammatory disease occurs clinically in various forms, intelligent treatment of necessity must differ for each type of lesion and is dependent on the extent and nature of the inflammatory reaction in the individual case. For practical purposes we found it expedient to describe our material as (1) primary cases, those patients who had no previous definitive surgical treatment, and (2) recurrent cases,—those patients with recurrent lesions and symptoms following previously unsuccessful, definitive operative treatment. Of 319 cases in this series, 241 (75 per cent) were *primary* and seventy-eight (25 per cent) were *recurrent* according to this classification.



## PRIMARY CASES

Table I represents the types of lesions encountered and the average duration of symptoms, for each type, prior to admission. Acute pilonidal abscesses, 29 per cent, were seen within a few days after onset of pain, the usual chief subjective symptom in this group. Chronic draining sinuses alone, 34 per cent, and chronic

TABLE I

TYPES OF INFLAMMATORY LESION AND DURATION OF SYMPTOMS IN 241 CASES OF PRIMARY PILONIDAL DISEASE

| Lesion                       | No. | Per Cent | Average Duration of Symptoms |
|------------------------------|-----|----------|------------------------------|
| Sinus.....                   | 83  | 34.5     | 6 mo.                        |
| Acute abscess.....           | 69  | 28.7     | 4 da.                        |
| Infected cyst and sinus....  | 64  | 26.5     | 8 mo.                        |
| Infected subcutaneous cyst.. | 21  | 8.7      | 4 mo.                        |
| Cyst and everted coccyx....  | 4   | 1.6      | 1 mo.                        |

sinuses associated with chronic cystic abscesses, 26 per cent, were usually symptomatic for months and when examined after excision were found to contain nests of hair almost without exception. On the other hand, chronic subcutaneous cysts alone, 9 per cent, with no demonstrable adjacent dimple or sinus contained chronic inflammatory granulation tissue, occasionally associated with mucoid pus, but in no such instance could hair be found within the lumen after excision. Everted coccyx was associated with pilonidal cystic disease in four patients who complained of pain. At operation the everted portion of the coccyx was removed with the cyst.

## RECURRENT CASES

As stated, pilonidal disease recurred after operation in seventy-eight (25 per cent) following one or more attempts to attain surgical cure. For a condition readily remediable by a simple surgical procedure, this recurrence rate seems enormous. (Table II.) Operation in about one-third of this group was done in civilian hospitals

prior to enlistment. Of great interest is the fact that two-thirds of the group in whom the type of previous operation could be determined had had some form of primary closure. In most of sixteen patients who had previously had some form of open operation, re-admission to the hospital was necessitated by failure of the wound to remain permanently healed following an unsuccessful trial at duty.

TABLE II

RECURRENCES AFTER PREVIOUS OPERATIONS—SEVENTY-EIGHT CASES

| No. of Previous Operations  | Cases           | Lesion                  |                    |                           |
|-----------------------------|-----------------|-------------------------|--------------------|---------------------------|
|                             |                 | Sinuses                 | Abscess and Sinus  | Abscess                   |
| 5                           | 2               | 2                       |                    |                           |
| 4                           | 1               | 1                       |                    |                           |
| 3                           | 3               | 3                       |                    |                           |
| 2                           | 14              | 11                      |                    | 3                         |
| 1                           | 58              | 49                      | 5                  | 4                         |
| Total.....                  | 78              | 66                      | 5                  | 7                         |
| Previous Operations         | Naval Hospital  | Civilian Hospital       | Civilian and Naval | Army Hospital             |
|                             | 48              | 24                      | 4                  | 2                         |
| Type of Previous Operations | Primary Closure | Open or Partial Closure |                    | No Information Obtainable |
|                             | 43              | 16                      |                    | 19                        |

This recurrence rate of 25 per cent in patients operated upon in various sections of the country by both military and civilian surgeons is excessive. It indicates that too few surgeons are sufficiently familiar with fundamental anatomic, pathologic and physiologic features of this problem, a clear concept of which is essential to attain satisfactory cures in this disease. Furthermore when it is noted that two-thirds of our recurrent cases followed attempts at primary closure, our criticism becomes more tangible. In the literature

recurrence is generally attributed to the fact that some portion of sinus tract remained in the wound due to incomplete

currence inasmuch as surgeons are generally cognizant of this pitfall in technic and are extremely careful to remove completely

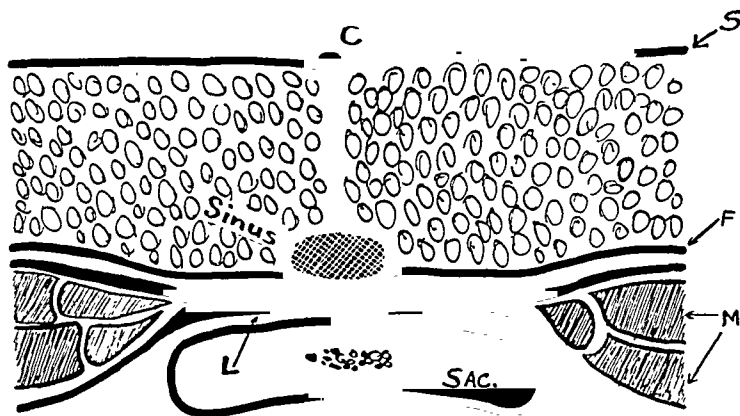


FIG. 1.

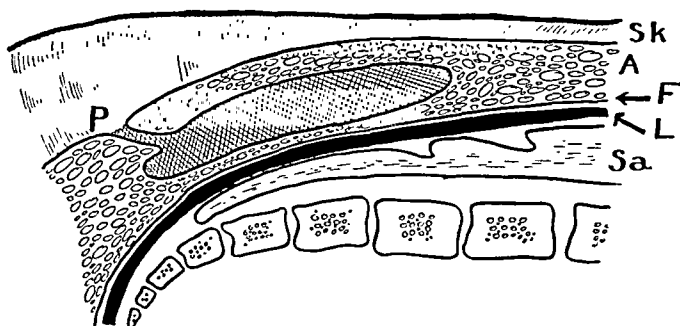


FIG. 2.

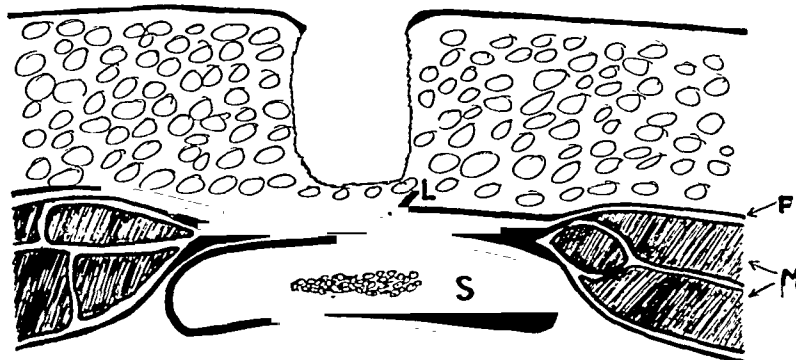


FIG. 3.

FIG. 1. Deep sinus recurrent following unsuccessful primary closure. C, cicatrix; S, skin; F, postsacral fascia; M, gluteus maximus muscle; L, posterior sacrococcygeal ligament.

FIG. 2. Sagittal section through a pilonidal cyst and sinus with related anatomical structures. P, cyst and sinus; SK, skin; A, areolar fat; F, postsacral fascia; L, posterior sacrococcygeal ligament; SA, sacrum.

FIG. 3. Transverse section following removal of cyst and sinus in a case favorable for primary closure. F, postsacral fascia; L, posterior sacrococcygeal ligament; M, gluteus maximus muscle.

removal and subsequently this acted as a nidus for reactivation of the infection. This factor is probably of infrequent oc-

all sinus tracts. We are in full accord with DePrizio's statement<sup>3</sup> that, "pilonidal cysts and sinuses when treated by radical sur-

gery do not recur as such. At secondary operation one seldom finds encysted material."

In most of our cases recurrent after unsuccessful primary suture we were impressed with the uniformity of the secondary lesion as to location and type of condition. In these patients well healed scars were found over the sacrococcygeal region. Typically at the distal extremity of said scar, deep in the natal fold, a draining sinus opening was found. Through this opening a probe could be passed into the sinus which extended cephalad deeply under the scar and directly over the sacrum. At secondary operation the healed cicatrix, formed by the previous approximation of subcutaneous areolar tissue and skin, was divided to expose a deep sinus tract containing friable, violaceous, chronic granulation tissue. (Fig. 1.)

Failure of permanent healing occurring with such uniformity must result from a fundamental error in surgical fabrication. That these poor results were not due essentially to defects in individual technique is shown by the fact, previously mentioned, that these forty-three wounds were primarily sutured by as many different surgeons in many parts of the country, presumably with a variety of individual methods and suture material. Furthermore, in many cases, recurrence took place many months after operation, some after one or two years. Remarkably enough, only the deepest portion of the repair, the region directly overriding the sacrum and coccyx, broke down. The skin and subcutaneous tissue which formerly was the seat of the bulk of the pilonidal disease remained firmly healed, the defect left by excision having been replaced by a firm, mobile, well healed scar. In a few exceptional cases, a secondary sinus opening penetrated the proximal portion of the scar.

To our mind the uniformity of the lesion found in our recurrent cases suggests the fact that the original surgeon disregarded fundamental factors in the repair of surgical wounds. That wound infection is

not the chief factor is shown by the fact that perfect healing took place in the subcutaneous tissues and that breakdown of the wound most often occurred months after operation and apparent cure. In reviewing much of the literature on the treatment of pilonidal disease by primary suture, it is obvious that most authors are not clear in their concept of the significant anatomy of the region. To elucidate, most writers describe the removal of the cyst and all possible secondary sinuses, "down to the sacral fascia." The impression is given that the postsacral fascia and the posterior sacrococcygeal ligament are analogous. This is far from true. (Figs. 2 and 3.)

Actually the postsacral fascia delimits the ventral extent of the very vascular, loose, fatty, areolar subcutaneous tissue to which this thin but firm, fibrous, fascial membrane is very intimately attached. A potential space separates the post-sacral fascia from the posterior sacrococcygeal ligament as demonstrated by the relative mobility of the fascia on the ligament when this tissue is exposed at operation. The posterior sacrococcygeal ligament on the other hand, consists of a firm, tendinous, shiny, relatively avascular ligamentous structure intimately attached to the periosteum of the sacrum and coccyx and confluent with the fascia of the gluteal muscles laterally. (Figs. 1, 2 and 3.) The distinction between fascia and ligament must be clearly understood as thereby lies the key to successful primary closure.

In dissecting the cysts and sinuses "down to the sacral fascia," it is probable that many surgeons unknowingly carry their dissection through the postsacral fascia thereby exposing the posterior sacrococcygeal ligament. They then proceed with an accurate closure taking care to avoid dead space and tension on the suture line. A sutured wound results presumably with accurate approximation of tissue in layers in the following arrangement: (1) skin to skin, (2) areolar tissue to areolar tissue and (3) areolar tissue and fascia to

posterior sacrococcygeal ligament. It is a well established physiological fact that healing of sutured wounds per primum is dependent upon a rich vascular bed in both approximated tissues. These criteria are satisfied in both the skin and subcutaneous areolar tissues in the sacral region so that excellent healing was expected and was in fact universally present in these tissues. However, it is physiologically unsound to expect firm union when richly vascular, fatty areolar tissue is approximated to posterior sacrococcygeal ligament, a tendinous, fibrous and practically avascular structure. A similar situation and principles apply to repair of inguinal hernia as pointed out by Seelig, by Joyce and by Gallie and Le Mesurier<sup>7</sup> who state that, "side-to-side suture of muscle (vascular) as in the suture of the internal oblique muscle to Poupart's ligament (avascular) results in union of practically no strength." Relative healing time is another factor to be considered in this connection. Firm healing of tissues (1) and (2) above, requires about ten days. One cannot reasonably expect strong union between areolar tissue and ligament, (3), in this short time. With resumption of normal activity by the patient rigid fixation of the suture line is disturbed resulting in potential disruption of union and possibility of development of a dead space.

Infection is another factor tending to disrupt firm union deep in the wound. Despite rigid aseptic operative technic, in excising pilonidal disease, cultures taken from the depths of the wound just before closure uniformly showed growth of septic organisms. In a small series of such cases we grew hemolytic staphylococcus albus in ten, anerobic streptococcus in six, hemolytic staphylococcus aureus in two, and streptococcus fecalis in one. The mechanism of recurrences following primary closure in most cases proceeds as follows: loss of fixation in the weak suture line between vascular subcutaneous areolar and avascular ligament in time results in a dead space, which becomes increasingly

infected in the presence of low grade septic organisms to manifest itself eventually as a deep sinus tract. That sepsis, though universal in these cases, is of low virulence is shown by the fact that the well vascularized skin and subcutaneous areolar tissues in these wounds heal firmly.

Recurrences following excision of pilonidal disease in which the wound was left open to heal by granulation were less commonly seen in our cases. In these, recurrences probably was due to insufficient wound drainage and to lack of careful postoperative wound toilet, thereby allowing bridging of granulations and subsequent formation of infected sinuses.

#### TREATMENT

A continuous series of 125 primary cases of pilonidal disease in which the patients were operated upon by a number of surgeons on our staff were reviewed. (Table III, Group 1.) The prolonged time required for complete healing, complications and early recurrences in many of these clearly indicated that utilization of haphazard methods and technics generally prolonged hospitalization for many of these patients. Standardization of treatment was instituted in the last eight-month period during which a comparative series of patients were studied. (Table III, Group II.) Operation in this group of 116 patients was performed by one of three surgeons and postoperative care was supervised by one of us.

It is generally accepted that primary closure of wounds following excision of chronically infected pilonidal cysts and sinuses, when successful, heals in the shortest time and affords the most satisfactory scar. Therefore, many cases in Group 1 ill suited for primary closure were nevertheless so treated on the assumption that if the wound became infected and broke down, sutures could be removed and the resultant gaping wound allowed to heal by granulation. Our experience, however, showed that the grossly infected wound healed slowly as does all infected granu-

lation tissue, so that in most of these cases eventual epithelialization was markedly prolonged. In fifty-seven cases closed per primum in Group I varied technics and a variety of suture material were used. Al-

of primary closure in this series based broadly on the type of suture material used. One method, emphasized the importance of a specialized regimen of pre- and postoperative care to minimize infection.

TABLE III

TYPE OF DEFINITIVE SURGICAL TREATMENT IN PRIMARY PILONIDAL DISEASE—LENGTH OF TIME REQUIRED FOR COMPLETE EPITHELIALIZATION OF WOUND

|                           | Early Series—Group I 26 Surgeons<br>Time in Weeks |           |          |          | Type Therapy                          | Late Series—Group II 3 Surgeons<br>Time in Weeks |          |           |           |
|---------------------------|---|-----------|----------|----------|---------------------------------------|--|----------|-----------|-----------|
|                           | No. Cases   | Short-est | Long-est | Aver-age |                                       | Aver-age   | Long-est | Short-est | No. Cases |
| Cysts and sinuses chronic | 57  | 2         | 21       | 6        | Primary closure                       | 2.9  | 10       | 2         | 61        |
|                           | 29  | 4         | 20       | 7.5      | Partial closure                       | 5.5  | 7        | 5         | 12        |
|                           | 6   | 6         | 10       | 7.5      | Open drainage                         | 7.5  | 16       | 8         | 7         |
| Acute abscess             | 33  | 4         | 28       | 9        | Varied—Group I Marsupialized Group II | 6  | 12       | 4         | 36        |

though a wound closed by primary suture should be well and firmly healed in fourteen days, complete epithelialization in three weeks was arbitrarily established as

TABLE IV  
EVALUATION OF METHODS OF PRIMARY CLOSURE OF PILONIDAL WOUNDS

| Methods   | No. of Cases | Successful Less Than 3 Weeks |    | Failure More Than 3 Weeks |    | Healed Average Time in Weeks |
|---|--------------|------------------------------|----|---------------------------|----|------------------------------|
|   |              | No.                          | %  | No.                       | %  |                              |
| Primary partial (skin drained) cotton-dermal tension..... | 18           | 12                           | 67 | 6                         | 33 | 5.5                          |
| Cotton-dermal tension....                                 | 13           | 4                            | 30 | 9                         | 70 | 9.0                          |
| Catgut-dermal tension....                                 | 16           | 8                            | 50 | 8                         | 50 | 7.0                          |
| Catgut-wire tension.....                                  | 21           | 15                           | 71 | 6                         | 29 | 3.8                          |
| Wire-wire tension (Ferguson).....                         | 50           | 45                           | 90 | 5                         | 10 | 2.5                          |

the criterion of successful primary closure, because some technics required delayed skin closure.  
Table IV demonstrates the average healing time required by the several methods

However, in a number of patients so treated preoperative preparation with wet dressings and bed rest required one to three weeks thereby nullifying the advantage of primary closure insofar as the time saving factor was concerned. Review of those cases in Group I classified as failures, (healing prolonged over three weeks), showed that breakdown of the wound usually was due to neglect of the fundamental physiological principles essential for proper wound healing. These included: (1) attempted closure of grossly infected areolar subcutaneous tissues too soon after incision and drainage of an acute suppurative pilonidal abscess; (2) attempted closure of defects so wide that suture lines cut through or gave way to excessive tension resulting in dead space and eventual infection thereof. A postoperative hematoma occasionally was seen.  
In our personal cases, Group II, interrupted sutures of fine chromic catgut were used in our early cases to close the wound. Through-and-through tension sutures of wire strengthened the suture line. (Fig. 6.)

An excessive number of these early wounds became infected despite the fact that the wounds were particularly favorable for

operation. Patient is placed in the inverted prone position with adhesive straps separating the buttocks. After meticulously

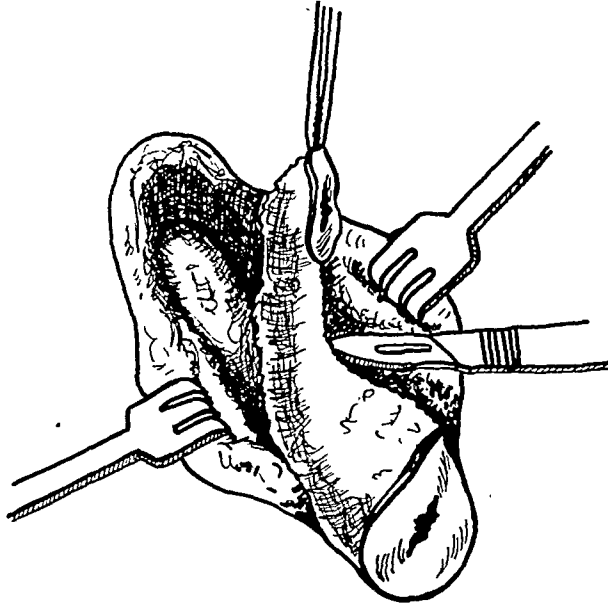


FIG. 4. Excision of sinus tract under local anesthesia.

primary closure. We attributed the breakdown in the wound to excess tissue reaction to the chromic gut. Tissue irritants combined with septic organisms always present in these wounds apparently overwhelmed the process of normal healing eventually resulting in gross infection. In the later cases of Group II, catgut was discarded as suture material.

#### PRIMARY CLOSURE

In the entire series the method of primary closure which afforded consistently good healing in the shortest period of time was that in which alloy steel wire was used throughout with a technic slightly modified from that described by one of us, (F.), in 1935.<sup>8</sup> In fifty patients so treated, forty-five (90 per cent) were completely epithelialized in two weeks, the average healing time for all patients was two and one-half weeks from operation to complete epithelialization. (Table IV.) Our present technic of primary closure follows:

Preoperative medication consists of phenobarbital 0.2 (gr. III) two hours before

preparing the field, procaine solution 1 per cent containing 8 m. of  $\frac{1}{1000}$  solution of epinephrine per ounce is infiltrated into the skin and subcutaneous tissues about the sinus tract and cyst, the extent of which can readily be determined in its superficial aspects by careful finger palpation. A local field block as well as a relatively avascular operative field results. The skin adjacent to and below the distal sinus opening is incised and dissected free. A towel clip through the distal sinus tract held in the operator's left hand and small sharp retractors on the skin margins held by the assistant serves to place the tissues under tension so that dissection of the lesion is markedly facilitated. (Fig. 4.) Chronicity of the lesion produces marked fibrosis around the cysts and sinuses so that with careful scalpel dissection the lesion can be shelled out removing only a minimum of surrounding normal skin and areolar tissue. It is essential to keep the level of the dissection as superficial as possible so as to preserve the all important post-sacral fascia. However, complete re-

moval of the infected sinus tract is essential. Lateral extensions are dissected out when found, additional procaine solution

re-draped. Microcrystalline sulfathiazole is frosted into the wound by means of a powder blower. Using a cervix needle, a

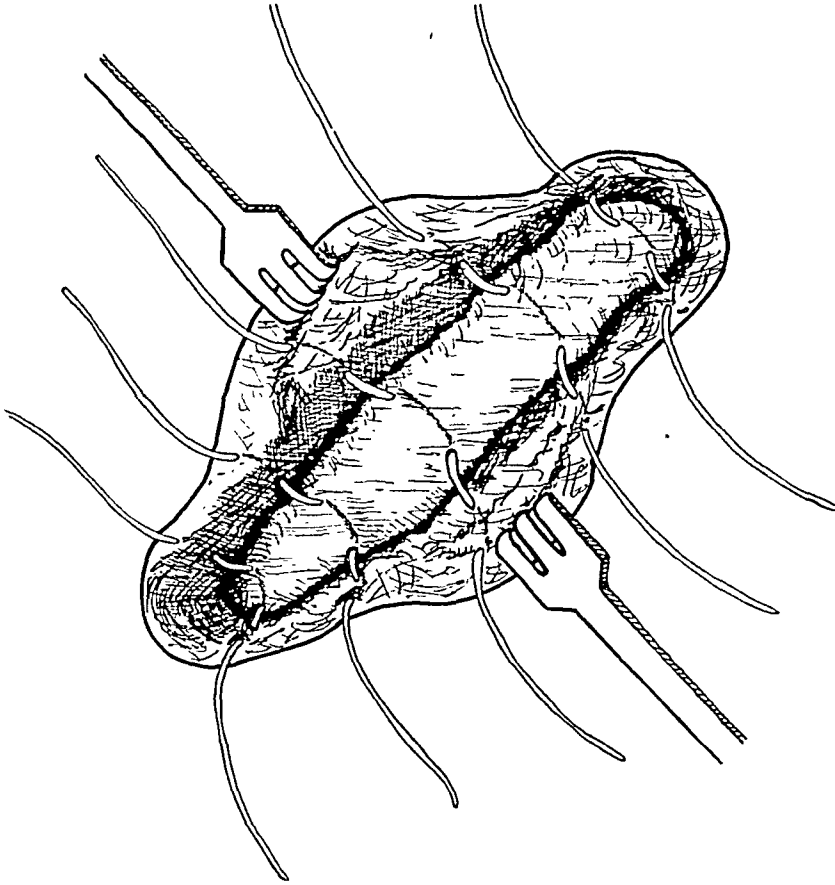


FIG. 5. Primary closure of pilonidal wound by use of approximating sutures of .004 alloy steel wire through deep areolar tissues incorporating the postsacral fascia.

being infiltrated when necessary. Bleeding is usually minimal, due to the use of epinephrine, and controlled by hemostats when encountered. A cross-section of a favorable case for primary closure after completion of the dissection of the lesion is illustrated in Figure 2.

The wound is considered favorable for primary closure if the lateral walls can be approximated without undue tension and only if the post-sacral fascia remains intact. Hemostats are now removed, residual bleeders if any are caught and tied with fine plain catgut and the wound thoroughly irrigated with saline. Adhesive retracting straps are removed and the adjacent skin is again prepared and

series of very fine alloy steel wire, .004 inch, sutures are placed at short intervals starting at the distal end of the wound. The suture incorporates the deep areolar tissue on both sides as well as a wide portion of the post-sacral fascia. (Fig. 5.) It is technically easier to place all the sutures before tying. Extremely fine wire is used for two reasons: (1) This very fine gauge wire gives rise to practically no tissue reaction; (2) its low tensile strength insures against excess tension in the wound. If the suture will not hold the approximated wound when tied, tension is considered excessive and primary closure in such a wound is therefore precluded. In deep defects, a second superficial layer of

.004 inch approximating sutures is used. All knots must be square, tied three times and cut on the knot to avoid sharp ends.

the patient is cautioned to sit only on the lateral portion of the thigh and buttock with the opposite leg crossed over the knee

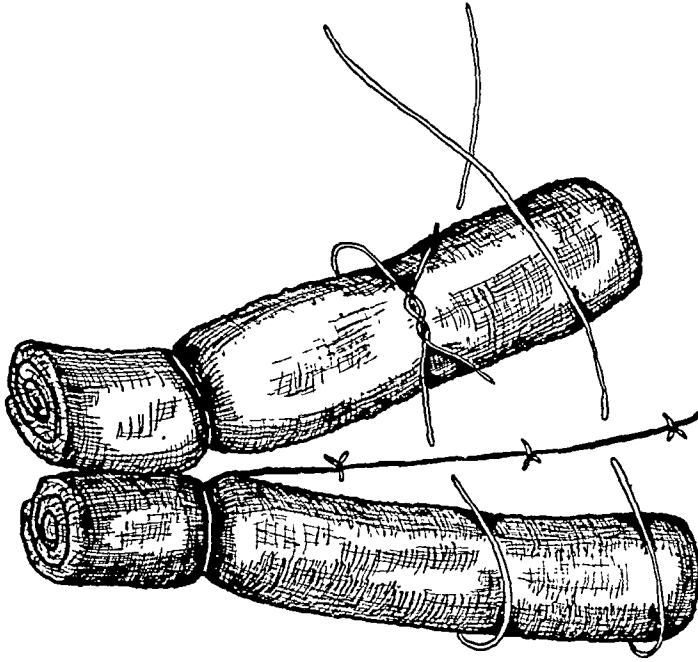


FIG. 6. Wound closure with .006 alloy steel wire vertical mattress sutures tied over gauze rolls. (Figs. 4, 5 and 6 after Ferguson, L. K. "Surgery of the Ambulatory Patient." Philadelphia, 1942. Lippincott.)

Microcrystalline sulfathiazole is liberally sprayed into the wound at frequent intervals as prophylaxis against gross infection.

Finally, through-and-through vertical mattress sutures of .006 wire are passed on large, curved cutting needles starting 3 cm. from the near skin edge. The near end is then threaded on a fine cutting needle and the skin edges are approximated. A few extra skin sutures may be required. The tension sutures are tied firmly over gauze rolls. (Fig. 6.) A dry dressing firmly held by wide adhesive straps placed across the buttocks completes the procedure.

The dressing is not disturbed for ten days but the patient may be ambulatory after the second day. Tension sutures are then removed, an alcohol dressing is applied and held with firm adhesive straps. Dressings are discontinued after the fourteenth postoperative day. To avoid pressure and tension on the fresh wound,

during convalescence and for some time thereafter.

In those cases in which one or more lateral sinus tract extensions were present, the lateral wounds were sutured first, then closure of the main wound was completed as described. Wound infection is suspected if pain, tenderness, induration and possibly rise in temperature occurs on about the fifth postoperative day. If on inspection of the wound induration is found to be localized, penicillin, 100,000 to 200,000 units, often will prevent complete breakdown of the wound and induration will rapidly subside. Continued inflammatory reaction going on to fluctuation requires removal of stay sutures and reopening the wound for drainage.

#### PARTIAL CLOSURE

Widespread chronic pilonidal cysts connecting distally with a sinus tract draining over the lower coccyx were present in



twelve patients of Group II. (Table III.) Lateral extension of the cyst necessitated extensive dissection which left a wide

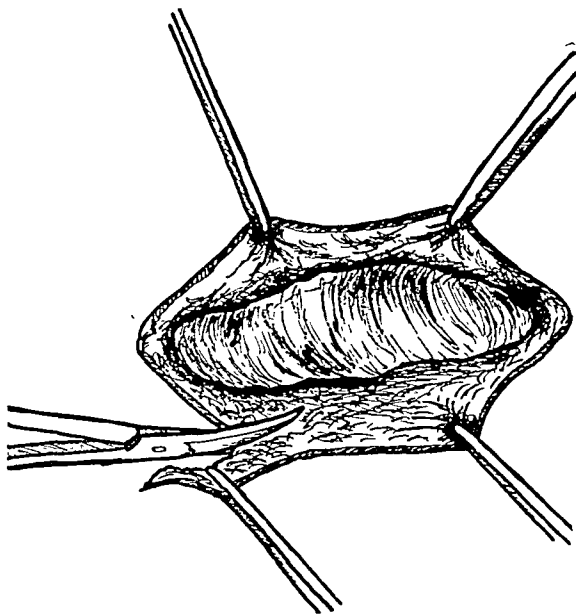


FIG. 7. Marsupialization of acute pilonidal abscess; saucerization of the wound. (After Buie.)

“banjo-shaped” defect. The width of the wound in its proximal portion precluded primary closure. However, in its distal portion primary closure was feasible and readily accomplished. The wide upper portion was then partially closed. The skin adjacent to the wound was mobilized by undercutting; wedges of subcutaneous fatty areolar tissue then were excised bilaterally to allow the skin to be drawn partially together thereby minimizing the width of the wound. The skin margins finally were secured to the underlying post-sacral fascia by several mattress sutures of alloy steel wire so that only a narrow central area remained to heal by granulation. These patients required four to six weeks for complete epithelialization.

#### ACUTE ABSCESS

Acute suppurative pilonidal abscesses occurred in 22 per cent of patients in this series. Military expediency required definitive treatment in one uninterrupted period of hospitalization as stated above. We found that the method of management to

be described resulted in the shortest period of hospitalization and afforded satisfactory end results.

Fluctuant abscesses were incised and drained in the ward dressing room on admission. Morphine sulfate gr.  $\frac{1}{6}$  administered intravenously just before incision provided ample anesthesia. Application of wet dressings were continued for two or three days until induration about the wound receded. Secondary operation was then carried out under sodium pentothal anesthesia. After exploration of the wound with probe and gloved finger, the wound was saucerized by liberally excising skin and subcutaneous tissues around the wound cavity. A marsupialized wound results similar to that described by Buie. (Fig. 7.) By means of a large spoon curette infected granulation tissue in the base of the wound was removed. After adequate hemostasis iodoform gauze was packed firmly in the wound. The pack was removed on the fifth postoperative day and the wound was allowed to heal by granulation. Daily wound toilet, frequent hot irrigations, control of exuberant granulation tissue by silver nitrate stick helped to promote rapid healing. Epithelialization was usually complete in four to six weeks as evidence by a firm, flat mobile scar. (Table III.)

#### RECURRENT PILONIDAL DISEASE

As stated two-thirds of our recurrent cases followed previously unsuccessful primary closures. Secondary operation was performed under sodium pentothal anesthesia. The sinus tract was exposed by cutting down on a grooved director lying in the sinus tract. This required incision through the overlying scar. Chronic granulations were removed with a spoon curette and wound edges were well saucerized. Iodoform packing completed the procedure. Recurrences after previous open type of operation were similarly treated by curettage and saucerization. Despite meticulous daily postoperative care and the use of all procedures in our therapeutic

armamentarium most of these wounds were very slow in healing. When the granulating wound had reached the skin surface it was found that epithelium would not grow across the small residual gap. The importance of adequate drainage in these wounds was demonstrated repeatedly in the more extensive wounds which extended from the tip of the coccyx to well up on the sacrum. The portion of the wound over the sacrum healed well and epithelialized rapidly. However, the lower portion in which drainage was obstructed by apposition of the buttocks, especially with the patient standing, healed sluggishly and final epithelialization was markedly protracted. In one patient who had had three previous operations for his recurrent lesion the distance from the depth of the pilonidal wound in the coccygeal region to the surface of the buttocks measured 8 cm. when the patient assumed the erect position. In this type of patient with a deep natal fold and large buttocks, adequate drainage was physically impossible. Chronicity of the lesion in the recurrent cases causes deposition of excessive fibrous tissue in the granular bed of the wound with resultant progressive inadequacy of the local tissue vascularity. This is another factor which retards healing.

Experience has shown us the difficulties in the surgical cure of patients with multiple recurrences. In several such recent cases, the local lesion was again excised thereby affording us a fresh clean wound. On this fresh wound, a split thickness skin graft taken from the lumbar back was fitted and sutured, then held firmly in place with a pressure dressing. The few cases in which the patients were so treated by the plastic surgical service have been eminently successful and this procedure appears to offer a solution to this very troublesome problem. Rank<sup>9</sup> has recently described a similar procedure.

#### SUMMARY

1. Pilonidal inflammatory disease is common in the Navy. At our Naval Hospital,

7.5 per cent of operations in a recent period were performed for the eradication of this condition. The definitive surgical treatment of a series of 319 patients was reviewed. Of these 241 (75 per cent) were primary admissions and seventy-eight (25 per cent) had previously had one or more unsuccessful definitive surgical operations.

2. Pilonidal cysts and sinuses can originate in embryo from the neurogenic medullary canal, from infolding of the dorsal epidermis or from both. Three clinical types result: subcutaneous cyst alone, (neurogenic); sinuses or dimple alone, (epidermal); subcutaneous cyst communicating with sinuses (neurogenic and epidermal).

3. We find no convincing evidence to prove that hair grows from the epithelium of pilonidal cysts. We believe that external hair grows into the sinus, extends into the cyst, breaks off from the external root and in time is moulded into "nests."

4. Pilonidal inflammatory disease in our clinical cases occurred in four main types: (1) sinuses, (2) acute abscesses, (3) infected subcutaneous cyst and sinuses, and (4) infected subcutaneous cyst alone. Treatment of these types varies for each type as well as for individual variations in type.

5. Recurrent pilonidal disease following previous definitive operation is common; seventy-eight cases in this series. In two-thirds of these, recurrence resulted from unsuccessful primary suture. With characteristic uniformity the lesion in most of these consisted of a deep sinus under a well healed scar. That fundamental surgical principles were disregarded by the original surgeon is indicated by the uniformity of the recurrent lesion. Relationship of surgical repair to the basic anatomy of the sacrococcygeal area is emphasized as a requirement for success in primary closure of these wounds.

6. It was demonstrated that haphazard technics of operation and postoperative management resulted in prolonged hospitalization of many of our patients.

In the second half of the series, operation and management of these cases was standardized under the care of three surgeons with resultant reduction in healing time in each type of case.

7. Patients amenable to primary closure were operated upon under procaine-epinephrine local anesthesia. The infected cyst and sinus was carefully excised and the wound was closed with fine alloy steel approximating sutures reinforced by through-and-through tension sutures of heavier wire tied over gauze rolls. Only five of fifty patients so treated required more than three weeks for complete epithelialization. The average healing time for all fifty patients was two and one-half weeks.

8. Cases necessitating wide excisions were partially closed by undermining the skin at the wound margins and suturing these to the post-sacral fascia, thereby minimizing the wound which is then allowed to heal by granulation.

9. Acute abscesses were drained on admission. Revision operation three days later consisted of marsupialization of the wound by saucerizing the margins thereof. Granulations in the base of the wound were curetted and healing allowed to proceed by granulation.

10. Recurrent lesions were explored after exposure, granulations were curetted and wound edges saucerized. As a rule, these healed poorly for two reasons: (1) depth of the lesion especially in the upright

position prevented adequate drainage; (2) chronicity of the lesion resulted in marked fibrosis in the wound bed with consequent embarrassment of adequate vascularity. In recent sluggish cases, the wound was excised providing a fresh clean wound. A split thickness skin graft was removed from the lumbar back and sutured onto the fresh wound. A pressure dressing maintained the graft. This procedure has afforded gratifying results in several recalcitrant cases.

11. In postoperative granulating wounds, meticulous and daily wound toilet is necessary to attain healthy granulations and early epithelialization.

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# STRICTURE OF THE MALE URETHRA

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IT is the purpose of this communication to present an analysis of eighty-seven cases of urethral strictures treated in an Army General Hospital overseas in a period of twenty-two months; 1077 cases of urethritis were treated during the same period. A description of the symptoms, signs, diagnosis, treatment and disposition of urethral strictures will be given.

Stricture of the urethra is the most insidious and at the same time the most common late complication of gonorrhea. Trauma is a more serious but less common cause of stricture. Inflammatory stricture is usually acquired in early life but often does not become manifest for years. When this is the case, there is an accompanying infection of the mid and upper urinary tract which is proportionate to the severity of the urethral obstruction. Early recognition of the presence of a stricture permits the institution of appropriate measures to prevent constriction and obstruction of the urethra. The treatment, though primarily palliative and not curative, may obviate subsequent pathologic changes in the mid and upper urinary tract.

All of the patients were in the third and fourth decades of life, except three in the fifth and three in the sixth decade. There were seventy-six patients who previously had gonorrhea, four had sustained severe trauma to the urethra, one had a congenital structure, and six denied any history to explain the presence of the lesion. Fifty-nine of the patients who had had gonorrhea had been treated with sulfonamides for their infection and seventeen had not had any of these agents. None had received penicillin and only three had been

treated with fever therapy. There were forty-nine white and thirty-eight negro soldiers in the group.

The presenting symptoms of our patients are shown in Table I.

TABLE I

|  |    |
|--|----|
| Chronic urethral discharge.....                          | 32 |
| Chronic urethral discharge and obstructive symptoms..... | 23 |
| Obstructive symptoms alone.....                          | 12 |
| Acute urethral discharge due to gonococcus.....          | 14 |
| No symptoms due to stricture.....                        | 6  |

Thirty-two patients complained of urethral discharge of long duration and usually manifested as a "morning drop." This discharge varied from a thin watery fluid containing epithelial cells and a few leucocytes to a mucopurulent fluid loaded with leucocytes. Twenty-three patients had a chronic urethral discharge and also complained of a weak, small, hesitant urinary stream. Twelve patients had the latter symptoms without noticeable urethral discharge. Acute gonorrheal urethritis was present in fourteen patients who also had stricture of the urethra. This was the second attack of gonorrhea for these patients. There were six patients who had no symptoms and in whom the diagnosis of stricture was made when cystoscopy was attempted for other reasons. The lapse of time between the original gonorrhea and the diagnosis of stricture varied from one to twenty-seven years, with the majority evenly divided between one and twelve years. Only ten patients were aware that they possessed a stricture before their current hospitalization. One patient with a known stricture of twenty years' duration entered the hospital with acute urinary retention. His temperature was 103°F. and he pre-

sented the signs and symptoms of severe urinary tract infection. This was the only patient of our series who was admitted in a critical condition. There was one patient admitted here six weeks after a bulldozer turned over on him and fractured his pelvis and ruptured his urethra. A suprapubic cystotomy had been performed at the time of injury, but no attempt had been made to restore the continuity of the urethra.

The following outline is adhered to in the investigation of patients with stricture of the urethra:

1. *History.* Careful attention is given to the duration of symptoms, especially to any history of antecedent upper urinary tract infection. It is also of paramount importance to discover how incapacitating the disease has been in relation to the type of military duty the patient has been performing. If the urethral discharge is present it is important to inquire into recent sexual exposures.

2. *Physical Examination.* A complete physical examination is made which includes palpation of the urethra, testicles, epididymes, prostate and seminal vesicles.

3. *Observation of the Patient during the Act of Urination.* The importance of this simple test is often overlooked, and deserves particular emphasis. Not only does it demonstrate the force and calibre of the urinary stream but it is an aid in following the subsequent course of the patient under treatment.

4. *Urinalysis.* Frequent examination of the urine is essential.

5. *Renal Function.* Evaluation of renal function is made by using the phenol-sulphonephthalein excretion test, the concentration test, and the non-protein nitrogen content of the blood.

6. *Calibration of the Urethra.* This is accomplished by passing curved steel sounds, woven or steel bougie a boules or woven bougies. If acute urethritis or prostatitis is present, calibration is postponed until the infection has subsided. In many instances there is chronic ure-

thritis which is kept active by a stricture. In such cases gentle calibration is performed to determine if a stricture is the underlying factor.

7. *Volume of Residual Urine.* Where possible a small soft rubber catheter is passed after the patient has voided to establish the amount of retained urine. If the stricture is impermeable, palpation of the bladder reveals the degree of distention.

8. *Smears and Cultures.* Smears are made of any urethral discharge and of the prostatic and vesicular secretion. Cultures are likewise made upon both chocolate agar and blood agar.

9. *Cysto-urethroscopy.* The use of an instrument with fore-oblique vision gives direct visualization of the stricture; the entire urethra and bladder can be examined if the lumen of the stricture permits the instrument to pass. It is most useful in visualizing the stricture and any exudate or ulceration of the urethra.

10. *Cysto-urethrography.* The urethrogram provides accurate information concerning the calibre and contour of the stricture.<sup>1</sup> A cystogram is usually made at the same time by first filling the bladder with the opaque solution which is instilled through the urethra without using a catheter. Ten per cent skiodan or sodium iodide solution gives satisfactory contrast, and films are made in both anteroposterior and oblique positions. An accurate idea of vesical function can be obtained by making a roentgenographic exposure during the act of micturition in the lateral oblique position.

11. *Pyelography.* Excretory urograms are made when there is no significant diminution of renal function.

Therapy of urethral stricture may be divided into a consideration of treatment of the stricture itself and that of the accompanying infection of the upper, mid and lower urinary tract. In civil life urethral strictures are treated as a rule in the office or out-patient department except in the most severe cases, and the patient

can carry out his daily business while his stricture is dilated at intervals over a long period of time. In the Army, however, a patient is usually treated in the hospital until ready for military duty. In addition, when the individual patient with stricture is evaluated it must be decided whether he will be able to perform full or limited military duty overseas, or whether he should be evacuated to the United States.

If the stricture is readily amenable to instrumental dilatation, as manifested by easy passage of curved sounds to a calibre of 24 or 26 French scale without bleeding, no further hospitalization is required. The patient is returned to duty with instructions to have his unit medical officer continue with calibration every one or two months. This type of patient required two to three weeks' hospitalization as the dilatations are done at six to seven-day intervals. In the technic of urethral instrumentation we instill a semi-fluid mixture of  $\frac{1}{2}$  per cent nupercaine solution or 4 per cent boric acid solution and a sterile water-soluble surgical lubricant before passing urethral instruments. This acts as an excellent hydrostatic dilator and insures complete lubrication. Fifty-six of our patients were treated in the above manner. Fifty-four of these strictures were 12 to 14 cm. from the meatus and two were 5 to 8 cm. from the meatus. The strictures that can be treated in this manner are the most favorable type and have a minimum of urinary infection. Sulfathiazole is administered for three days prior to dilatation and for several days thereafter.

Internal urethrotomy is a valuable procedure to increase quickly the calibre of a stricture in selected cases. Our criteria for the use of this operation are as follows:

- (1) The stricture is not impermeable.
- (2) The stricture is located in the anterior urethra, i.e., within the penile or bulbous urethra.
- (3) The stricture is not amenable to dilatation due to: (a) tortuous lumen, (b) associated bleeding from the adjacent urethra distal to the stricture, and (c)

inelasticity of the stricture due to dense scar tissue. (4) The stricture is of small calibre, i.e., less than 18 French scale.

The operation is done under spinal or caudal anesthesia, and the Maisonneuve type of urethrotome is used. After the stricture is cut, further dilatation is carried out by the passage of curved steel sounds. A soft rubber catheter, 20 or 22 French, is then left in the urethra for not more than three days. While the catheter is in place, sulfathiazole 1.0 Gm. four times a day is given. On the seventh or eighth post-operative day, dilatation of the urethra is started and is continued at weekly intervals until the calibre remains constant and the wound in the urethra has healed. About one month of postoperative hospitalization is necessary for these patients. When they return to duty they are instructed to have urethral calibrations at intervals of one to two months. There is very little bleeding at the time of the internal urethrotomy, which is in accord with the fact that most urethral bleeding following instrumentation for stricture comes from the adjacent mucosa. The stricture is relatively avascular. Patients who have undergone internal urethrotomy have amazingly little discomfort and all notice a marked improvement in their urinary stream when the catheter is removed. Internal urethrotomy was the treatment of choice for twenty-six of our eighty-seven patients. Three of these strictures were 5 to 8 cm. from the meatus, and twenty-three were 12 to 14 cm. from the meatus. The type of stricture that meets the criteria for internal urethrotomy is severe and on instrumentation alone a prolonged period of hospitalization is required. The value of internal urethrotomy lies in the fact that simple incision of dense scar tissue is less traumatic to the urethra than dilatation accomplished by repeated passage of steel sounds.

External urethrotomy was the procedure of choice in four patients. The indication for the operation was the presence of an impermeable stricture caus-

ing urinary retention. Three of these patients had post-inflammatory strictures of long duration, associated upper urinary tract infection and diminished renal function. One of them entered critically ill with acute urinary retention and a prostatic abscess. The drainage of the infection and the relief of the bladder obstruction were accomplished by perineal section. Calibration of the urethra was started eight to ten days after the operation. However, because of the severity of the stricture and the effect of longstanding stasis, these patients could not be sent to duty. The fourth external urethrotomy was performed upon a soldier who six weeks previously had suffered a ruptured membranous urethra and a fractured pelvis. A suprapubic cystotomy had been performed at the time of injury, and at the time of admission to this hospital he had an impermeable stricture and was on suprapubic drainage. An external urethrotomy was performed and a seton was passed through the urethra to the bladder at the time of operation; dilatation was then carried out using the seton as a guide. It is not in the province of this article to discuss the management of rupture of the urethra, several aspects of which have been stressed elsewhere by one of the authors.<sup>2</sup> The best results in the treatment of rupture of the bulbous urethra have been obtained by immediate external urethrotomy, whereas the operative management of rupture of the membranous or prostatic urethra consists of combined suprapubic and perineal approach. Furthermore, the stricture resulting from trauma calls for a long period of observation and calibration as the scar tends to be more dense than that following inflammation alone.

As a corollary to treatment of stricture of the urethra, it is important to stress that no urethral instrumentation should be performed if there is a co-existing acute infection of the urethra, prostate, seminal vesicles or epididymes. In addition, gentle instrumentation is essential as much harm will be done if the operator is rough.

It also must be stressed that a stricture is composed of scar tissue which will always be present, so that any operative procedure must not be regarded as a cure, but as a means to permit dilatation of the stricture in order to obtain a urethral calibre that is compatible with normal urinary function.

The complications of instrumentation of urethral strictures are transient bacteremia or so-called "urethral fever," peri-urethral abscess, urethral fistula, extravasation of urine, and acute epididymitis, prostatitis and pyelonephritis. The only complications that we encountered were in two patients who developed acute pyelonephritis, one after internal and one after external urethrotomy.

The criteria for the return of the soldier with urethral stricture to full military duty are as follows: (1) The patient is asymptomatic. (2) The urinary stream is free and of good calibre. (3) There is no upper urinary tract infection or impaired renal function. (4) There is no active urethritis, prostatic-vesiculitis or epididymitis. (5) The urine sediment is free of cells and casts. (6) The calibre of the stricture is at least a 22 French and of such nature that a curved sound can be easily passed.

If the patient does not meet the above requirements, he cannot be properly cared for in the field. Seventy-one of our patients were returned to full duty. Six patients were returned to the United States because of the stricture and associated upper urinary tract infection. Ten patients were returned to the United States because of other diseases and not because of their urethral strictures. The four patients who underwent external urethrotomy and one patient who underwent internal urethrotomy were among those returned home because of stricture. One patient who also had benign hypertrophy of the prostate was not treated but evacuated home, because it was not thought justified to start treatment overseas because of the long hospitalization and eventual disposition.

## SUMMARY

1. Eighty-seven cases of urethral stricture in which the patients were treated at a General Hospital overseas are reviewed.

2. The majority (seventy-six) of the strictures were a sequel to gonorrhea; four were post-traumatic, one was congenital, and in six the history was non-contributory as to cause.

3. Chronic urethral discharge and difficulty in urination were the main presenting symptoms. However, fourteen had acute gonorrhea.

4. The urologic investigation of urethral stricture is outlined with emphasis on the value of (1) observation of the patient with stricture during the act of micturition, (2) cysto-urethroscopy and (3) urethrography.

5. The treatment and indications for the type of treatment are outlined.

6. Fifty-six patients were treated by urethral dilatation; twenty-six patients had internal urethrotomy, and four had external urethrotomy. One patient received no instrumental treatment.

7. Seventy-one patients were returned to full military duty; six were returned to the United States because of urethral stricture and its complications, and ten were evacuated home because of reasons other than urethral stricture.

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# INTUSSUSCEPTION\*

## DIAGNOSIS AND TREATMENT

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AT the Rhode Island Hospital, Providence, Rhode Island, during the ten-year period from 1934 to 1944, thirty-five patients with intussusception have been treated, ranging in age from five weeks to sixty years. Of this group, thirty-one were operated upon, with five deaths, or a mortality of 16.1 per cent. Of the other four, two died shortly after admission to the hospital, and the other two had spontaneous cures, probably resulting from the physical examinations to which these patients are usually subjected. This can readily be appreciated when one considers that the average time elapsed between admission for this condition in this hospital has maintained an average of one every three and one-half months.

That intussusception is a disease of extreme youth has been ably demonstrated by Ladd and Gross in 1934 in their report of 372 cases and again by Kahle in 1941 in his report of 151 cases.

The name is derived from two Latin words: "intus" meaning "within," and "suscipere" meaning "to receive." Or more specifically "a receiving within" and interpreted in surgical circles as the invagination or indigitation of a portion of the intestine into an adjacent portion. It was first described by John Hunter in 1789.

There are four varieties: (1) Ileocecal, in which the ileum and the ileocecal valve pass into the cecum and colon; (2) colic, in which the large intestine is prolapsed into itself; (3) ileal or jejunal, as the case may be, in which the small bowel is invaginated into itself, and (4) ileocolic, in

which the ileum passes into the ileocecal valve.

The invagination of a lower portion of the bowel into a higher part may also occur. As there was no incidence of this latter type of disorder, only those cases in which the intussusception has occurred from above downward within the gastrointestinal tract will be considered in this report.

Of these thirty-five cases the sex incidence varies little from the predominantly male percentage presented by other writers. There were twenty-four males or 68 per cent and eleven females or 32 per cent.

Of the female group there were three patients who were over seventeen years of age, or approximately 25 per cent. In the male age group, there were seven cases occurring in patients eight years old or over. All of the others occurred in infants and twenty-one of these infants were under one year of age. The other three were between one and two years.

In further breaking down the age percentages, twelve cases occurred in infants under six months of age, or 33 per cent. An additional 22 per cent occurred in the age group between six months and one year, or a total of 57 per cent. Of the entire group, there were three cases occurring between birth and three months of age. In Table 1 a composite picture of sex and age and the percentage in each is given.

The etiological factor in the entire series is as obscure as it has always been. There were seventeen cases in which the cause could be found at operation. The remaining fourteen patients operated upon had no apparent etiology. In view of these

\* The opinions expressed herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

| Age              | Male | Female | Male, Per Cent | Female, Per Cent | Total, Per Cent |
|------------------|------|--------|----------------|------------------|-----------------|
| Under 3 mos..... | 3    | 0      | 8.57           | 0                | 8.57            |
| 3-6 mos.....     | 4    | 5      | 11.58          | 14.15            | 25.73           |
| 6 mos.-1 yr..... | 7    | 1      | 18.86          | 4                | 22.86           |
| 1-2 yr.....      | 2    | 0      | 5.72           | 0                | 5.72            |
| 2-10 yr.....     | 4    | 1      | 11.26          | 3                | 14.26           |
| 10-20 yr.....    | 2    | 2      | 5.71           | 5.71             | 11.43           |
| Over 20 yr.....  | 3    | 1      | 8.58           | 2.85             | 11.43           |

findings, the treatment of the disease must still be delegated to the correction of the acute symptoms at the earliest possible moment. In the age group up to one year, there were twenty patients of whom three were treated without operation. Eleven of the remaining seventeen cases demonstrated no definite etiological factor at the time of operation. The six patients in which a cause could be seen have a representative in each of the etiological groups as shown in Table II. It is, therefore, sufficient to say that a definite pathological background in the infant group is no better known than ever. In the older ages, particularly adults, a cause was always found. This included in this series all eight operated patients over ten years of age.

| Cause                                | Total | Under 1 Year | 1-10 Years | Over 10 Years |
|--------------------------------------|-------|--------------|------------|---------------|
| None found.....                      | 14    | 11           | ..         | 3             |
| Tumor in intestine.....              | 6     | 1            | 1          | 4             |
| Meckel's diverticulum...             | 4     | 2            | 1          | 1             |
| Adhesive band.....                   | 4     | 2            | 1          | 1             |
| Hyperplasia of lymphoid tissues..... | 3     | 1            | ..         | 2             |
| Not operated.....                    | 4     | 1            | ..         | 3             |

Of the four varieties of intussusception usually encountered, as already defined above, the most common is found in the region of the cecum, either ileocolic or ileocecal, and in this series amounted to 50.7 per cent of the group. The ileocolic type was found in ten cases (28.5 per cent).

The ileocecal valve was incorporated in the intussuscepted mass in eight cases (22.2 per cent). This particular anatomical area was further increased by the five cases presenting multiple intussusception, all of which showed the ileocecal region as one of the points involved. These twenty-two cases presenting pathological conditions in the region of the ileocecal valve were all infants under thirteen months of age, with the exception of four adults. The five cases presenting multiple intussusception included three infants under seven months of age, with an ileo-ileal and ileocolic intussusception of unknown etiology, and one adult female thirty years of age with an ileo-colic and ileo-ileal intussusception resulting from a fibroma of the ileum. The other patient presented a colocolic and ileocolic intussusception in an infant nine months old. Thus of the entire series, 62.8 per cent presented the condition in the lower right quadrant.

There were two patients in the group presenting large bowel disorders only. The first was a seventeen year old female, who presented a ceco-cecocolic intussusception arising from a soft tumor of the cecum. The other occurred in a boy of six who presented a colocolic intussusception at the splenic flexure with no apparent cause. The remaining six patients operated upon demonstrated the disorder in the small intestine alone, five in the ileum and one in the jejunum. Two of these patients fall into the group in which no cause could be found. The ten-year old boy with a jejuno-jejunal intussusception was found to be suffering from an adenocarcinoma of the jejunum. The oldest patient in the group, a man age sixty, with an ileo-ileal intussusception was found to have a fibroma of the ileum. The first patient was a re-operated patient who had complained of abdominal pain for three months prior to admission, and had had an appendectomy seven weeks previously. The apparent etiological factor producing the condition was omental adhesions arising following the appendectomy. The sixth case occurred

in a fifteen-year old boy, with a Meckel's diverticulum, in a section of which pancreatic tissue was found by the pathologist. This same patient had been ill for three days before admission, presented a gangrenous intestine which was resected. He subsequently died on his fourth day of peritonitis.

DISTRIBUTION—AGE AND TYPE, AGE

| Type                   | 1-3<br>Mos. | 3-6<br>Mos. | 6<br>Mos.<br>-1<br>Yr. | 1-2<br>Yrs. | 2-10<br>Yrs. | 10-20<br>Yrs. | Over<br>20 |
|------------------------|-------------|-------------|------------------------|-------------|--------------|---------------|------------|
| Ileocecal .....        | ..          | 5           | 3                      | ..          | ..           | 1             |            |
| Ileocolic .....        | *1          | 3           | 2                      | 1           | 1            | ..            | 2          |
| Colic .....            | ..          | ..          | ..                     | ..          | 1            | 1             |            |
| Ileal or jejunal ..... | ..          | ..          | ..                     | 1           | 1            | 3             | 1          |
| Multiple .....         | ..          | 1           | 3                      | ..          | ..           | ..            | 1          |
| Total .....            | *1          | 9           | 8                      | 2           | 3            | 5             | 4          |

\* 5 weeks old male, not operated. Pathology demonstrated at autopsy.

EIGHT RESECTIONS, AGE

| Type                           | 6<br>Mos. | 8<br>Yrs. | 10<br>Yrs. | 13<br>Yrs. | 15<br>Yrs. | 17<br>Yrs. | 30<br>Yrs. | 60<br>Yrs. |
|--------------------------------|-----------|-----------|------------|------------|------------|------------|------------|------------|
| Ileocecal .....                | *1        |           |            |            |            |            |            |            |
| Ileo-ileal .....               | ..        | 1         | ..         | 1          | †1         | ..         | ..         | 1          |
| Jejunojejunal .....            | ..        | ..        | 1          | ..         | ..         | ..         | 1          |            |
| Ileo-ileal and ileocolic ..... | ..        | ..        | ..         | ..         | ..         | ..         | ..         |            |
| Ileocolic .....                | ..        | ..        | ..         | ..         | ..         | 1          |            |            |

\* Died one-half hour after operation, of shock.

† Died on fourth postoperative day, of peritonitis.

Although this portion of the series represents only 20 per cent of the patients operated upon, it is interesting to observe that only one occurred in infancy without involvement of the ileocecal valve.

Subjective and objective symptomatology in the series shows no remarkable variation from the usual classical picture. Temperature changes in the entire series varied from subnormal to 103.6°F. The younger patients, as is the case in most types of disease, had a tendency to run a higher temperature. There were, however, ten of the patients who showed no temperature. The average for all of the patients was 99.8°F. or very similar to most groups of patients admitted for appendicitis. The common symptoms observed were those usually encountered in the evaluation of any acute condition of

the abdomen, but the most constant were nausea and vomiting, occurring in twenty-two out of the thirty-five patients and abdominal pain in the same number. Diarrhea and distention occurred in four and five patients, respectively, and rectal bleeding was observed in eleven. A mass was palpable abdominally in twenty-one patients and rectally in eight. It is interesting to record that three of the eight patients in whom a mass could be palpated rectally, no abdominal mass could be observed. This again merely emphasizes how important can be the evaluation of the patient as a whole, with rectal examination a possibly serious omission if not done. It would also demonstrate quite conclusively that the typical textbook picture cannot always be reliable. The type and character of the mass palpated in the abdomen was not in any of the cases compared to the customary and too infrequent "olive, lime, sausage, lemon or grapefruit," but described as extending "throughout the right lower quadrant," "small or large," "below and to the right of the umbilicus," or as the case might have happened to be. This type of description is obviously much better than the more indefinite comparisons to common variables. Diagnosis was made preoperatively in twenty-four cases and confirmed at the time of operation. The remaining seven patients were operated upon because they had signs and symptoms of an acute surgical condition of the abdomen. Although the mortality was comparable to others recently reported in this serious surgical condition, not one of the seven patients who were not diagnosed previous to operation failed to recover. This again bears out the oft disputed rule that little harm can be done by simple laparotomy in cases in which there is reasonable doubt. In arriving at the point of decision as to the proper type of treatment, the general appraisal of the patient was probably given the greatest consideration. It can be an indisputable opinion that a patient requiring surgery of the abdomen can be

diagnosed from the history and physical examination in a large majority of cases. The dispute that arises always in the evaluation of these procedures is the exception for which a complete study in the laboratory and x-ray department are so vitally necessary. The use of the barium enema as a diagnostic procedure was limited to only three patients. Two of these were admitted shortly after the onset of symptoms and the third was over twenty-four hours old. In each patient the condition was correctly diagnosed, but not cured by the procedure, as has been reported by other observers. The white blood count was also extremely variable, and equally unreliable, ranging from 7,000 in a case which was a few hours old to 35,000 in one of the cases which terminated fatally.

Surgical therapy in each of the thirty-one patients operated upon consisted of reducing the intussusception from below upward in all cases except those that required resection. The practice of traction on the proximal loop of bowel is to be condemned as much as an obstetrician would condemn traction on the umbilical cord during the third stage of labor. If the mass cannot be reduced by gentle pressure over the distal point of intussusception, the possibility of the need for resection must be given more immediate consideration. Some writers have advised that this situation should be handled by suturing the bowel in place around the mass, leaving the mass to slough out. The advanced degree of shock may make this decision necessary, but a mortality is almost certain to follow this procedure. The risk of providing some means of diverting the intestinal stream is also great, but attended by a smaller mortality, as statistics have definitely shown. The incision in these cases was some type through the right rectus muscle, either splitting or retracting in twenty-seven of the thirty-one patients operated upon. Of the other four cases, three incisions were through the left rectus muscle and the fourth was through a right

transverse incision. The relationship of mortality to the type of incision cannot be very satisfactorily demonstrated in such a small series of cases. Of the five deaths, three were in the group of patients in whom a right rectus incision was made, one left rectus, and the last the only transverse incision in the entire group. It is interesting to note that the patient in whom a transverse incision was made was five months old, had been ill for thirty-six hours previous to operation, was one of the three patients in whom a barium enema had sustained the diagnosis, had passed bloody stools, had a Meckel's diverticulum as the etiological factor, and died on the operating table. The type of incision many times may have a direct bearing on the end result, and although the incision that follows the natural skin creases has in my experience proved to be more physiological, it does consume more time in reconstructing, particularly if the rectus muscle has been divided in the line of the skin incision. It would, therefore, follow that intussusception in an infant should contraindicate any incision that is more time consuming, particularly if a general anesthetic has been used.

Resection of a loop of bowel was necessary in eight patients of the series, two of whom died on the fourth and eighth postoperative days, respectively. An ileo-transverse colostomy was performed on one other patient in whom a tumor could be felt in the cecum. This patient was discharged on his fifteenth postoperative day and returned for the second stage six weeks from the time of the first operation. Recovery was prompt and uneventful following resection of the terminal loop of ileum, cecum and ascending colon. In these eight cases a side-to-side anastomosis was performed rather than end-to-end. This is unquestionably the better procedure, particularly if the experience of the operator is limited. The technical details of a side-to-side anastomosis consume a little more time, but the complications are much less troublesome.

Appendectomy constituted a part of the operative technic in thirteen of the operated group, whether the appendix appeared to be involved in the etiological process or not. Fortunately none of these patients were among the few deaths, but appendectomy as a routine procedure in the treatment of such a possibly serious condition is to be condemned, unless it can be shown to be definitely diseased.

Of the entire group of operated patients that recovered, the average hospitalization was fourteen days. The shortest hospitalization was a nine months old infant, discharged on the seventh postoperative day, following operation which revealed the ileocolic and a colocolic intussusception. The longest hospitalization was twenty-six days, and was necessary in two patients. The first was a mal-nourished eight months old infant in which no complication had occurred following the reduction of an ileocolic intussusception. The second was a thirty-two year old male who developed pneumonia on his fourth day following the reduction of an ileocecal intussusception.

Other complications following operation were limited to four patients, the remainder of the group surviving operation following an uneventful course. Abscess of the leg developed in a two and one-half year old female following hyperdermoclysis. Atelectasis, which was bronchoscoped in an eight-year old boy, was followed by an uneventful recovery and discharge on his thirteenth postoperative day. These two patients were the only complications encountered in the group of eight in whom some type of intestinal resection had been performed. Evisceration occurred on the sixth postoperative day in a seven months old infant, was resutured the same day and the patient discharged recovered fifteen days later. Intestinal obstruction occurred in a three-months old male infant a month after discharge, following operation for an ileocecal intussusception. At the reoperation numerous adhesions were found.

The actual mortality of 16.1 per cent in the patients operated upon is increased to an over-all mortality of 17.1 per cent for treatment of the entire series, because of the death of one patient admitted in a moribund state and not operated upon. A fifteen-year old male died on his fourth postoperative day of intestinal gangrene and peritonitis. At the time of operation a section of 15 cm. of gangrenous bowel was resected. The second death occurred in a one-year old male on his fourth postoperative day of lobar pneumonia. The third has already been mentioned, dying on the operating table. The fourth patient was a six-months old infant with an ileocolic intussusception in which the terminal ileum and part of the ascending colon were gangrenous at the time of operation. The fifth death occurred in a six months old female who had been sick for three days prior to operation and was one of the group in which resection was performed. This patient also died about one-half hour after operation.

Recurrent intussusception and its treatment did not enter into any portion of this report as there were no cases available in which a diagnosis had been definitely established. One patient admitted twice during the period of this report had a presumptive diagnosis of recurrent intussusception, but at each admission did not seem to offer sufficient diagnostic evidence for operation, and was discharged each time after a hospital stay of a few days. The low incidence of recurrence in this condition as shown in this series and reported by other writers should be a stimulus for a greater effort to determine the etiology by more complete and meticulous observation.

#### SUMMARY

1. Thirty-five cases of intussusception occurring at the Rhode Island Hospital Providence, Rhode Island, from 1934 to 1944 have been recorded.

2. An operative mortality of 16.1 per cent is reported.

3. A cause was found at operation in 49 per cent of the series.

4. The sex incidence was 68 per cent males and 32 per cent females.

5. Resection was necessary in eight cases, with two deaths.

6. The value of a complete study prior to early operation in this acute surgical abdominal condition is again emphasized.

7. The possibility of determining the etiology of this disease in a greater percentage of patients in the future is forecast.

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PYLORIC occlusion with secondary vomiting and dilatation of the stomach occurs either from cicatricial contraction or from the swelling and edema associated with an ulcer. Rare complications are the occlusion of the bile duct with stone formation and jaundice; and pancreatitis from invasion of the pancreas or obstruction of a pancreatic duct.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# VALUE OF SALPINGOGRAPHY IN SURGICAL DIAGNOSIS

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IN dealing with the so-called adnexal mass, the experienced surgeon and gynecologist are often unable to anticipate or plan the correct operative procedure because of their inability to identify its origin, type or definitive pathology. Difficulties in the differential diagnosis of this particular class of pelvic abnormality arise from several generally recognized sources.

Unfortunately, in a large proportion of adnexal tumors, a marked resemblance in the consistency, conformation, size and position, as well as in the intrinsic degrees of pain and tenderness is manifested by distinctly dissimilar tubal, ovarian or tubo-ovarian masses. Very seldom in these cases is an accurate differentiation of textbook clarity available from data obtained by careful laboratory study and history. Furthermore, the similarity between adnexal and uterine tumors not uncommonly met with in bimanual examination, may also be the basis of error in identification.

The adnexal growth presents no greater diagnostic problem than when it must be differentiated from the low abdominal tumor; and especially since an intestinal or renal tract neoplasm may be present which requires specific preoperative preparation of the patient and special surgical technics best performed by the urological or abdominal surgeon, the clinical importance of this distinction requires no further emphasis.

An obese abdominal wall, the patient's resistance, and the examiner's subjective error or personal factor are also sources of incorrect diagnosis, which although of academic interest, constitute a relatively frequent and important barrier, germane to all clinical problems of this type.

In view of these obstacles, it is not surprising that diagnosis of tubo-ovarian conditions has been the subject of numerous contributions to surgical literature. Descriptions of the operative findings include not only different and unexpected types of adnexal disorders, but also extrapelvic entities such as prolapsed kidney, gastric tumors (greater curvature), volvulus of the small intestine, large bowel neoplasms, mesenteric growths, congenital anomalies and many others.

Brief reference to the embryology, simple anatomy and physiology discloses several factors to which many of the erroneous diagnoses in this tumor group may be attributed.

Both tube and ovary, arising from the same embryonal cell mass, develop mutually, progressively and in intimate association. They are integrated into a structural and functional unit by connecting folds of peritoneum, the mesovarium, the mesosalpinx, the infundibulo-pelvic and the utero-ovarian ligaments. These serve not only as common, fixed supports and cohesive links but also provide for spontaneous changes involving rotation, displacement and movement, by virtue of their suspensory, elastic, tenuous and pivotal characteristics. The embrace of the ovary by the distal portion of the Fallopian tube and the fimbrial attachments to the upper pole of the ovary (*extremitas tubaria*) are supplementary evidences of this complete unity. Furthermore, the similarity in the sources and distribution of their vascular, neurologic and lymphatic networks adds to the already strikingly common pattern of close relationship of both structures.

Thus, it is not difficult to understand why the tube and ovary, mutually inte-

grated, exhibit a functional reciprocity in the physiological mechanism of ovular migration; or why changes in size, shape ring in adjacent structures. Thus, salpingography, supplemented when desired, by stereoscopic studies, has proven to

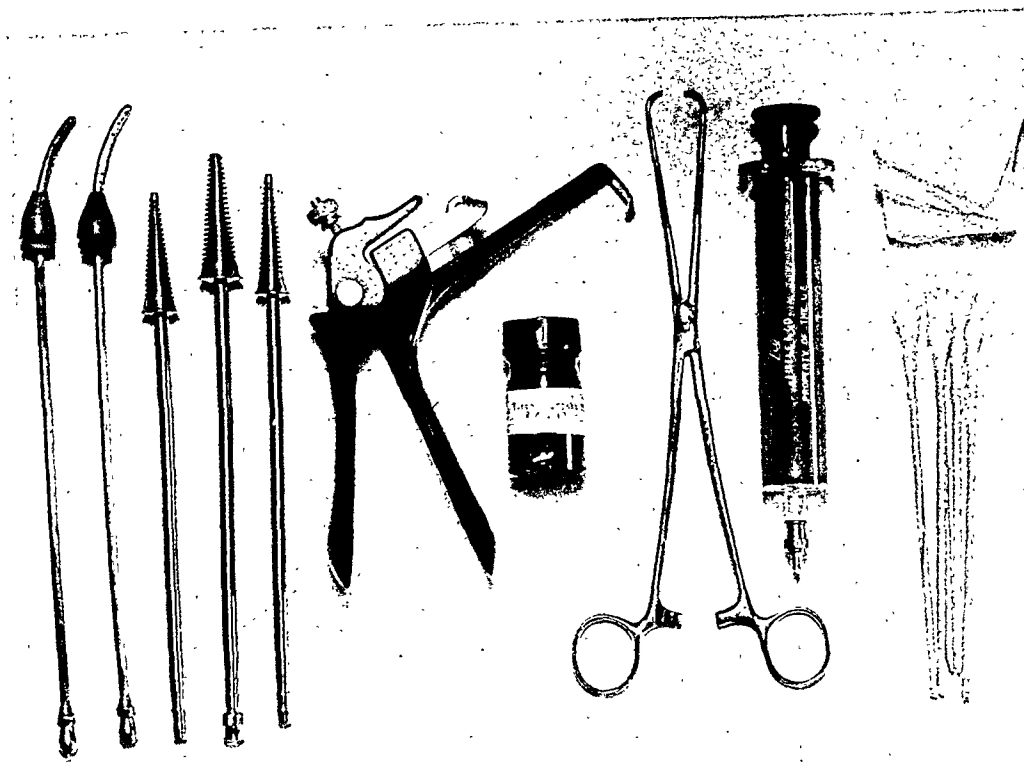


FIG. 1. Instruments required for salpingography; from left to right, perforated cannula, Colvin screw cannula, non-opaque speculum, Viscorayopake, tenaculum and 20 cc. syringe with adapter.

and position of the ovary, due to ovarian tumors, for example, will be reflected in the corresponding Fallopian tube by elongation, modified course and displacement; or, finally, why, under conditions of disease or growth, these closely related structures produce coalescent or confluent masses, rather than separate, demarcated and easily distinguished tubal or ovarian entities.

The shortcomings of bimanual examination, clinical history and laboratory findings, and the evident anatomical and physiological unity of the adnexal structures explain the principal bases upon which errors in diagnosis are made. In view of the foregoing considerations, it would seem that the Fallopian tube, because of its unique anatomic setting and possibilities for x-ray visualization, could serve as a graphic index of changes occur-

be a valuable aid in the visualization of adnexal masses, and warrants more widespread use. This simple x-ray test has proven safe, rapid and inexpensive.

With spectacular certainty, it may determine by tubal outline not only the pelvic origin of an obscure abdominal mass (Fig. 4), but, conversely, may confirm (by normal tubal x-ray shadow) the presence of an abdominal tumor in the pelvis. The synthesis of an obscure and confluent tubo-ovarian mass may be better understood if, around the tubal component visualized by x-ray, its ovarian element may be reconstructed (Fig. 10) to fit the clinical pelvic findings. Thus, by the tubal shadow determinant, the exact extent of either ovarian or tubal growth with relation to the adnexal mass as a whole, may be ascertained. Intra-



tubal carcinoma (Fig. 4), although rare, may be also detected by the irregular shadow characterized by moth-eaten, bi-

to outline the contour, size and position of contiguous tumors. (Figs. 7, 9 and 11.)

With the aid of stereoscopy, a three



FIG. 2. X-ray evidence of bilateral excretion of Viscorayopake, thirty minutes after intrauterine injection. Note unabsorbed residuum still in pelvis.

zarre patterns within the tubal wall, not unlike that observed in uterine cavity malignancy. (Fig. 4.) Differential diagnosis between a uterine and ovarian growth (Fig. 11) is very often simplified by visualization of a displaced or extrapelvic tubal shadow, produced by traction or pressure, incidental to ovarian enlargement. Not infrequently also, the presence of intraligamentous growths (ovary, uterus, cervix or paroophoron) due to their symmetrical and upward pressure on the superposed tube, may be confirmed by a linear tubal shadow of smoothly arched convexity. Thus, the x-ray details of position, course, curvatures and torsion reflected in the tubal shadow may serve

dimensional shadow is projected. This establishes not only a spatial relationship of the tumor with the bony pelvis and adjacent pelvic viscera, but also often defines the lobulations, direction of growth (Fig. 9) and size of the mass involved. Further information and verification is often obtained by contrast with genitourinary tract and lower bowel x-rays.

Salpingography, in recent years, has become a rapid and simple office or hospital procedure, and has achieved sufficiently uniform success to take its place among the accepted tests employed in surgical diagnosis. Its uses in the study of sterility and in the determination of tubal patency in conjunction with the

Rubin insufflation test (and its use in visualizing intrauterine growths by cavity distortion) have been described in the literature.<sup>17,23,24</sup>

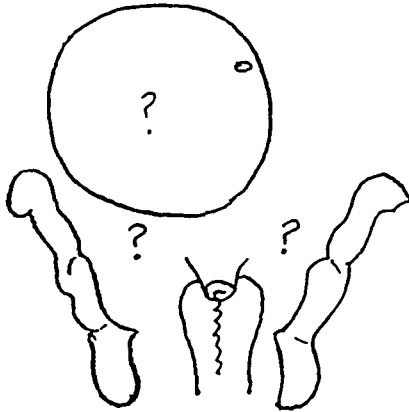


FIG. 3. Sketch of pelvic findings (Case 1) showing obscure mass in left lower abdomen. No pelvic structures palpable except bleeding cervix. Relationship between mass and genitalia not determined.

Since 1910, rapid advance in roentgen visualization of the pelvic viscera has been made by a number of workers.<sup>1,2,4,5,6,7,8,12,13,15,25</sup> These authors have contributed to our present knowledge by their experiences with various radiopaque media, methods of introduction and technic of radiography. The principal retarding factor confronting all these investigators was the inadequacy of the many opaque substances heretofore used. Such shortcomings as tissue irritation, insufficient opacity, unsatisfactory viscosity, toxicity, slow absorption and chemical instability were common to one or another of the substances used.

The recently introduced fluid substance, Viscorayopake\* has eliminated these objections and appears finally to have satisfied the requisites of an ideal opaque x-ray medium. As observed in the roentgen films, its renal excretion begins quickly. The dye may be observed in the kidneys and ureters (Fig. 2) within thirty minutes

of intrauterine instillation, even while the pelvic shadows are still present. The renal shadows usually persist until the pelvic dye is completely absorbed, but often may



FIG. 4.—Hysterosalpingogram (Case 1) showing shadow defects along right uterine wall suggesting malignancy; and rarely observed type of left tubal shadow, elongated, dextroverted, distally enlarged French horn type, containing shadow defects indicating neoplasm.

disappear before this point. From serial studies of pelvic and renal tract shadow intensity, it may be concluded that the rates of pelvic absorption and renal excretion in the same patient are roughly proportional. These factors, however, may vary in different individuals because variations in peritoneal absorption and renal threshold undoubtedly play an important rôle. The complete disappearance of Viscorayopake\* takes place rapidly.

In the diagnosis of the adnexal tumor, the technic employed is similar to that used for hystero-graphy which has been previously published.<sup>24</sup> In view of certain changes particularly essential for the delineation of tubo-ovarian masses only, it

\* Chemical structure: Diethanolamine salt of 2,4-dioxo-3-iodo-6 methyl tetrahydropyridine acetic acid. Three and one-half per cent concentration of polyvinyl alcohol is added to procure satisfactory viscosity.

\* Viscorayoke was furnished by Hoffman LaRoche, Nutley, New Jersey. The clinical use of this chemical was first described by I. C. Rubin in 1941, from the Mount Sinai Hospital in New York City.

is presented with revision and in somewhat briefer form.

*Method.* The patient, who has taken 2 dr. of licorice powder the night before,

angle (for the direction of the canal). Asepsis is carried out by vulvovaginal cleansing with soap and water and the use of sterile drapes.

FIG. 5.

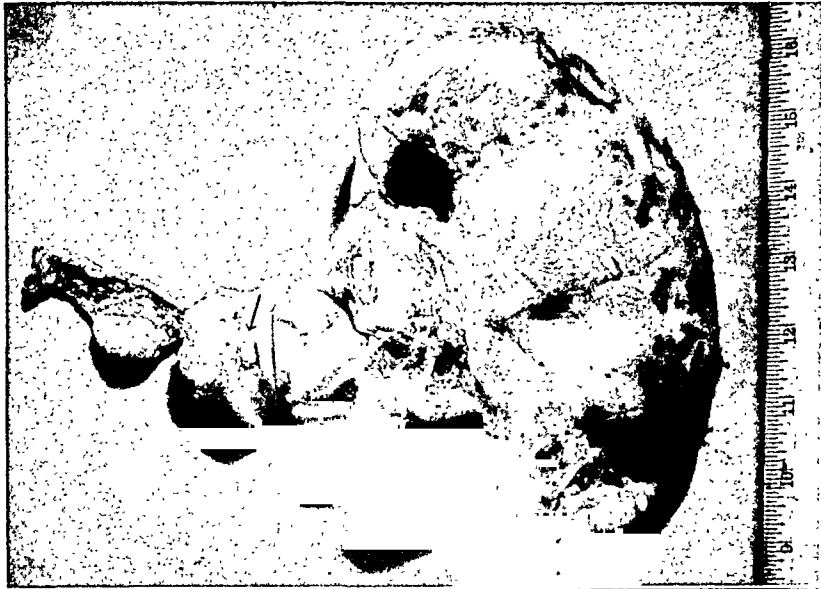


FIG. 6.

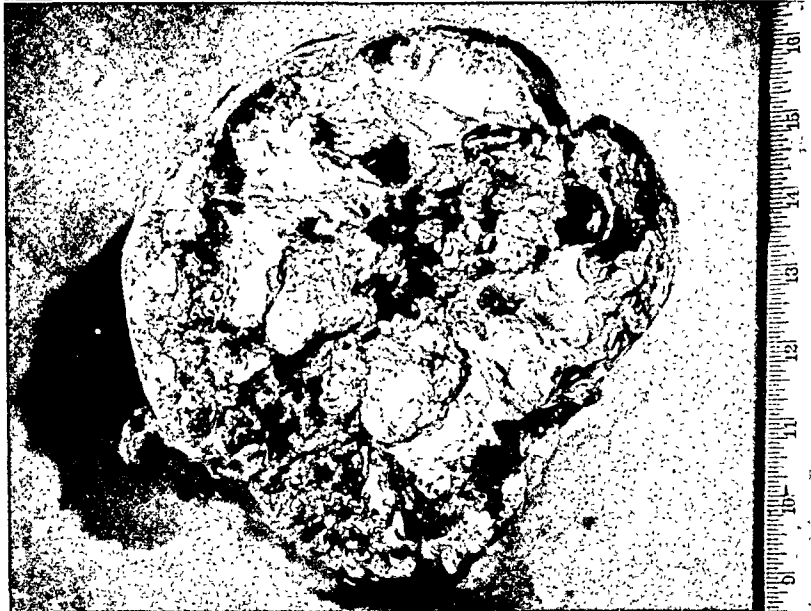


FIG. 5. Specimen (Case 1) showing right uterine wall carcinoma and enormous left tubal carcinoma. Note similarity in size, course, displacement, elongation, etc., of specimen with the tubal shadow in Figure 4.

FIG. 6. Cross section of solid tubal carcinoma (Fig. 5), with early signs of hemorrhage, liquefaction and aseptic necrosis.

and an enema two hours before the test, is examined bimanually, in the lithotomy position, on a Squier genitourinary table, in order to determine the cervico-uterine

A non-opaque bivalved speculum is used to expose the cervix, the external os of which is wiped dry and painted with tincture of iodine.

A 20 cc. syringe containing 15 cc. of Viscorayopake is fitted with a Luer metal tip and connected to either a uterine stem

scout film, is first taken in order to exclude phleboliths, calcified lymph nodes, unabsorbed radiopaque substances such as



FIG. 7. X-ray showing left tubal semilunar shadow (Case 11) due to the effect of a contiguous ovarian cyst. (Fig. 8.)

perforated cannula, as used in the Rubin test, or, to a Colvin<sup>16</sup> cervical stainless steel cannula. (Fig. 1.) The latter has proven especially satisfactory in preventing backflow, where a wide cervical canal is encountered. After displacing the air from the syringe and also from its contained dye substance (air bubbles may cause errors in diagnosis), the cannula is inserted into the external os in the direction of the cervico-uterine axis until the perforated tip lies within the cavity. When the Colvin screw tip cannula is used, simple rotation effects entry. Grasping the cervix with tenaculum forceps is a painful procedure, and unnecessary except in cases requiring traction for better cervical exposure, for an obstructive cervix, or where counter-pressure is required to prevent leakage.

The patient's pelvis is placed in proper alignment with the x-ray tube and plate. Ordinarily, 50 milliamperes and 58 primary volts for a two-second exposure, with a focal plate distance between thirty and thirty-six inches is ample. A flat plate, or

lipiodol used in previous tests, or intragluteal bismuth residue.

From 4 to 6 cc. of Viscorayopake are then injected, very slowly, intermittently and cautiously, with light or moderate pressure, in order to avoid uterotubal spasm. While the film is being taken, firm pressure is maintained on the piston of the syringe, in order to prevent leakage. After the patient is x-rayed, variable quantities of the dye may be suctioned back. With uterotubal blockage, very often all the chemical may be recovered. The wet x-ray film may be inspected immediately. On rare occasions, tubal obstruction or closure is diagnosed when tubal shadows are not found. In these cases, I have found it advantageous to repeat the test using a still slower rate of injection. Often complete tubal patency is revealed in these subsequent tests. Too rapid injection may cause hypertonicity and irritability, producing bilateral sphincteric spasm in the uterotubal muscle, thus preventing access of the dye into the Fallopian tube.

The patient usually described varying degrees of discomfort in the central suprapubic region, which radiates laterally as the

the test until active bleeding, incidental to the menses or any other cause, has subsided. During the interval phase of ovula-

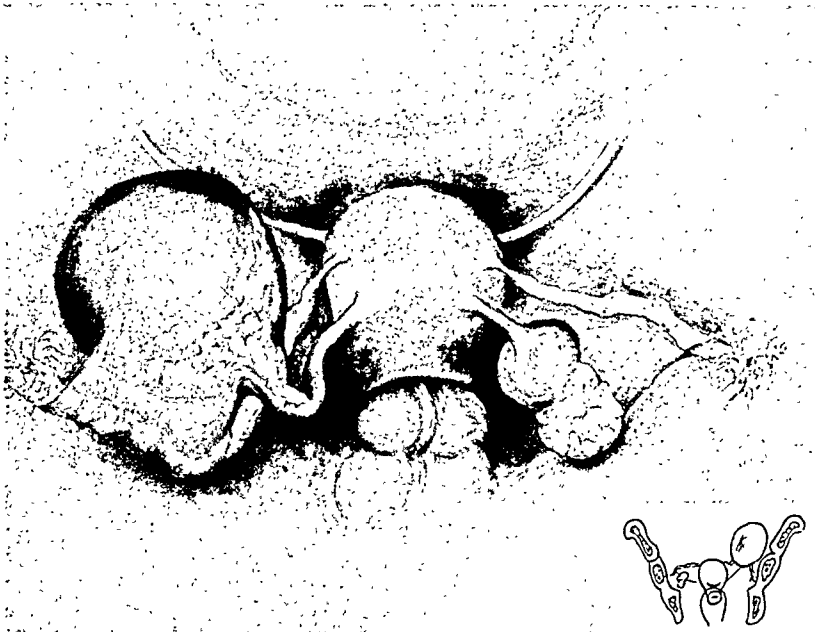


Fig. 8. Drawing showing operative findings of left tube deviation due to left ovarian cyst corresponding to salpingogram in Figure 7. Inset sketch indicates preoperative findings.

fluid advances correspondingly along the tubal canal. Contact with the pelvic peritoneum not infrequently gives rise to generalized lower quadrant pain or discomfort, but many patients complain of no pain whatsoever. These signs are fairly reliable in predetermining not only the site of partial or complete obstruction, but also in ascertaining tubal patency.<sup>22</sup>

Within fifteen minutes of the last injection, the patient may sit up and usually is immediately ambulatory. Transitory nausea, vomiting, discomfort, or mild pain occur in about half the patients. Severe reactions occur rarely. Petit mal was noted in two patients who had a history of childhood convulsions and syncope.<sup>24</sup> Recovery in both instances was immediate and there were no sequellae. When nervousness or apprehension is encountered, the use of mild sedation in preparation for the test is worthwhile.

Moderate uterine bleeding is not strictly a contraindication, but it is wise to defer

tion, the six-month postpartum period, or for thirty days after surgical procedures, salpingography may likewise be postponed.

Among other contraindications to the test are acute pelvic infections, acute endocervicitis, gonorrhea, intrauterine or ectopic pregnancy and cervical carcinoma. Epilepsy, petit mal, hysteria and psychoneurosis may be considered conditions which are unfavorable and possibly hazardous.

Sedation and smooth muscle anti-spasmodic drugs in small doses have been found useful in preventing uterotubal spasm which may occur in markedly nervous women, or due to sphincter irritability induced by a too rapid introduction of the fluid medium.

In order to describe and emphasize important differential criteria, brief case histories are presented in connection with examples of diagnosis by salpingography.

#### CASE REPORTS

The following presentation illustrates three diagnostic features: (1) differentia-

tion between abdominal and pelvic tumors,  
(2) identification of the pelvic origin and,  
(3) the type of tumor.

was discharged without further surgery with a diagnosis of hypertensive heart disease and abdominal tumor of undetermined origin.



FIG. 9. Salpingographic evidence in an unreported case of a right ovarian cyst. Stereoscopically, the tube is found to course posteriorly and downward, then forward and laterally underneath the cyst, which is encircled in its ascending portion.

CASE 1. Mrs. L. A., a fifty-eight year old housewife, visited our out-patient department on May 17, 1943, complaining of alternating watery and bloody vaginal flow, which began in 1941, after one year of menopause. Increased girth and weight (114 to 210 pounds), ankle edema, precordial pain and dyspnea, and urinary incontinence were additionally noted. The menstrual cycle had been normal. Sterility since 1923 followed delivery of a stillborn by forceps. Except for influenza in 1918, there were no illnesses.

Between July 8 and December 29, 1942, she was observed at another Naval Hospital for vaginal bleeding, an abdominal mass and heart disease. Curettage performed on December 12, 1942, under low spinal anesthesia (10 mg. pontocaine in glucose) revealed "a normal symmetrical uterine cavity, four inches in length" and "hyperplastic endometrium and small pieces of hemorrhagic and white tissue." After complete clinical and x-ray studies she

Our physical examination revealed a florid, obese, myxoedematous female of broad, short stature with moderate facial hirsutism, edentulous gums, bilateral gynecomastia and a markedly pendulous abdominal wall. The pulse, temperature and respirations were normal. The history of decompensation, the hypertension (200/94), the apical systolic murmur and our x-ray and electrocardiographic evidence of myocardial disease confirmed the discharge diagnosis of "hypertensive heart disease with relative coronary insufficiency." The lungs were clear.

Through the thick, adipose panniculus, a large, globular, fixed tumor was vaguely outlined in the right lower quadrant. A fluid wave was not demonstrable. An abdominal scout film showed "no definite tumor mass," while barium enema x-ray plate showed the "rectosigmoid colon displaced mesially."

Pelvic examination disclosed a parous, scarred, and thin perineum and a retracted,

atrophic and fixed cervix, which reflected no effects from traction or pressure upon the abdominal mass. (Fig. 3.) The lower extremi-

proved and she had decreased her weight by forty pounds.

At operation, at the Newport Hospital, on

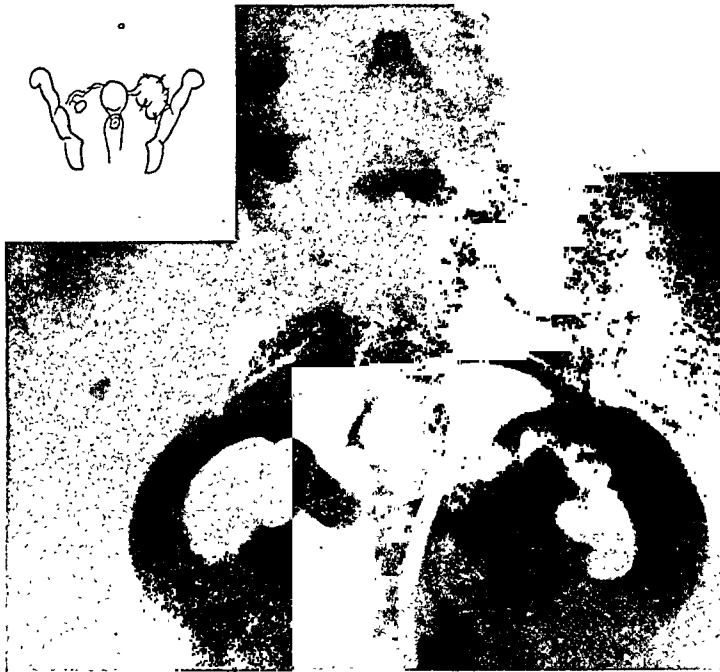


FIG. 10. Salpingogram (Case 111) indicating left hydrosalpinx and right chronic salpingitis, unanticipated because complete study and history of patient was negative. Inset sketch shows preoperative unilateral findings which suggested adenomyosis.

ties were normal except for ankle edema and generalized varicosities.

Laboratory tests including urine and blood examinations, Kahn test, non-protein nitrogen blood level and sedimentation rate were within normal limits.

Hysterosalpingography performed in the presence of moderate bleeding, with Vis-corayopake, revealed (Fig. 4) a symmetrical enlarged uterine shadow with an irregular, mottled defect along the right border, characteristic of malignancy. The right tube was not visible. The left tube rose completely out of the true pelvis, and ascended contralaterally to the level of the right iliac crest, where, turning sharply downward, it broadened gradually, then markedly, in its distal portion, somewhat like a French horn. In the latter area, numerous moth-eaten defects suggested a silhouette, characteristic of carcinoma.

Because of the poor operative risk (cardiac disease, obesity, varicosities and age), surgery was deferred until her general condition im-

proved. On September 24, 1943, under nupercaine spinal anesthesia, the left tube was found to be enormously enlarged and transformed into an intact, squash-shaped tumor, nine inches long and four to five inches wide. Dense adhesions to the cecal colon and bladder fixed it firmly in the right pelvis.

The uterus and both adnexae were removed. On opening the specimen, a solid tubal carcinoma and two areas of malignant growth in the uterine cavity were grossly observed. (Figs. 5 and 6.) Microscopically, adenocarcinoma was reported in the left tube and in the uterus.

The patient made an uneventful recovery. She refused both x-ray and radium therapy, and, when last seen, one year after operation, had no clinical evidence of metastases.

Because of the variance of our uterine findings with those of the curettage performed only nine months prior, the original microscopic slides were requested. These showed definite uterine adenocarcinoma. Accompany-

ing the microscopic slides was a corrected diagnosis confirming this fact.

The following case illustrates x-ray di-

semicircular curve conforming to the surface of its attached ovarian growth.

At operation in the Newport Hospital, June



FIG. 11. Salpingogram (Case IV) showing extrapelvic ascent of right tubal shadow verifying ovarian origin of tumor.

agnosis of ovarian cysts by means of the tubular shadow.

CASE II. Mrs. C. B., aged twenty-two years, married two years, complained of left lower quadrant pain, radiating to the opposite side, which increased after coitus, exercise and at menses. There was occasional resultant nausea. A three-month interval oligomenorrhea, which characterized the cycle since a delayed onset at fifteen years, was replaced by normal periods after marriage. The family history was irrelevant. The patient recalled no illnesses or somatic symptoms and had gained eight pounds in the past two years. Kahn test, blood count and urine examinations, sedimentation rate and chest x-ray were normal.

The physical findings were entirely normal except for a movable orange-sized cyst of the left ovary. (Fig. 8 inset.) Flat plate of the pelvis failed to reveal calcific elements of a dermoid cyst. Salpingography (Fig. 7) revealed an outline of the left tube coursing upward in

16, 1944, a tennis ball-sized cyst was excised from the left ovary. (Fig. 8.) The pathological diagnosis was simple ovarian cyst.

The accuracy in the identification of origin and pathology of an obscure adnexal mass, in the absence of helpful clinical or laboratory data is next shown.

CASE III. Mrs. M. I., aged thirty-two years, married nine months, complained of headache, dyspnea, weakness, a three-week menstrual cycle with dysmenorrhea, constipation, diarrhea or bloody stools and a forty pound weight gain. An appendectomy (1933) and a cholecystectomy (1939) were performed at the Truesdale Hospital, Fall River, Massachusetts. There were no other symptoms referable to pelvic disease and no history of venereal infection.

Examination revealed a tall, overweight, phlegmatic, myxoedematous, ill appearing individual with stooped posture. Physical



abnormalities and laboratory findings, including complete blood count, urinalysis, sedimentation rate and Kahn test were normal. X-ray of the chest and cranial sinuses showed no

rhagia and a suprapubic mass of two months' duration. She was discharged from the hospital by her physician with a diagnosis of fibroids of the uterus.

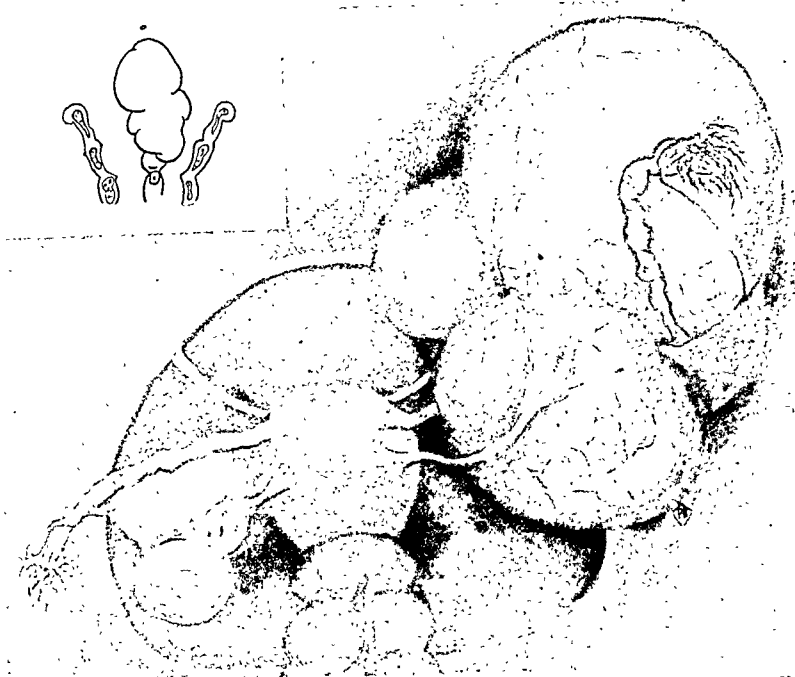


FIG. 12. Drawing of operative pathology (Case IV) showing tube ascending and partially encircling a right ovarian papillary serous cystadenoma. Note correlation of tubal shadow in Figure 11 with operative findings. Inset shows sketch of preoperative findings.

evidence of infection. The basal metabolic rates were  $-22$  and  $-25$  per cent.

Pelvic bimanual examination (Fig. 10 inset) revealed an irregular, resistant, non-tender, fixed, left adnexal mass. The fundus was retroposed, small and tender. The right adnexae were not felt. The cervix showed no erosions, and on movement, caused no pain. A mucopurulent discharge suggested endocervicitis but several endocervical smears revealed no gonococci. Both preoperative diagnoses, adenomyosis or ovarian tumor, which generally call for surgery, were rejected in view of the x-ray findings.

The salpingogram (Fig. 10) with Vis-corayopake medium indicated bilateral tubal disease and left hydrosalpinx.

Correct differential diagnosis between uterine, tubal and ovarian masses is illustrated by the last instance.

**CASE IV.** Miss D. W., a twenty-one year old student nurse, complained of menometror-

Her history, complete blood count, urine findings, sedimentation rate and Kahn test were all within normal limits. Physical examination revealed no somatic abnormalities except for a globular, irregular, resistant, immobile, suprapubic mass reaching one inch above the umbilicus. (Fig. 12 inset.) Its lower pole seemed confluent with an unenlarged, retroposed uterus. The left adnexae appeared normal. The cervix was normal and found high up in the vaginal vault behind the pubis. A diagnosis of ovarian cyst was made. Hysterosalpingography revealed the right Fallopian tube ascending to the level of the fifth lumbar body in the midline. X-ray diagnosis: extra-pelvic ovarian cyst. (Fig. 11.)

After readmission to the Newport Hospital, she was operated on March 30, 1943, under gas-oxygen-ether anesthesia. A large, extra-pelvic, multilocular, right ovarian cyst was found. (Fig. 12.) The right tube spiralled directly upward over the tumor, forming an

incomplete arc. There were no adhesions or points of rupture in the cyst wall.

A right oophorectomy was performed, care being exercised to preserve the integrity of the contiguous Fallopian tube.

Follow-up hysterosalpingography revealed bilateral tubal patency.

#### SUMMARY

1. Both gynecologists and surgeons recognize the difficulties and shortcomings in the diagnosis of the adnexal mass.

2. The interdependant anatomic relationship between the tube, ovary and their supporting structures most frequently is the direct cause of this problem.

3. Because of this close unity, the structural and kinetic changes which take place in the adnexae are often reflected by the Fallopian tube. X-ray visualization of the tube, therefore, furnishes a unique index, by which various types of adnexal disorders may be distinguished.

4. Salpingography serves to: (1) differentiate between uterine and ovarian tumors, (2) distinguish intraligamentous growths, (3) determine whether a mass is of pelvic or abdominal origin, (4) delineate ovarian tumors as to their size, position and contour, (5) establish, in the confluent adnexal masses, by exclusion, the size of the ovarian component, as well as the visualized tubal elements, and (6) diagnose chronic tubal disease, new growths and partially or completely obstructive tubal masses.

5. Viscorayopake has proven to be an ideal medium for pelvic x-ray. It is excreted rapidly by the kidney.

6. Contraindications to salpingography are stated.

7. Four cases and the pelvic x-rays of

each are presented to illustrate various differential diagnoses, made possible by salpingography.

8. The method is simple, rapid and innocuous; and is suitable for use in a hospital or any properly equipped office. This test lends itself successfully to the differential diagnosis of the adnexal tumor and has proven so successful that its more widespread use is recommended and anticipated.

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# INTESTINAL INJURY AND FECAL FISTULA IN GYNECOLOGICAL SURGERY\*

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THE small or large intestines may be injured during any gynecological laparotomy. An injury occurs most often on separating adhesions found between the intestines, the pelvic viscera and the abdominal wall. These adhesions may be the result of pelvic inflammatory disease or previous operations. This is shown by the high incidence of fecal fistulas following surgery for pelvic inflammatory disease. MacLaren<sup>1</sup> reported seventy-seven cases of intestinal fistulas in a series of 1,500 major abdominal operations; forty followed gynecological surgery, of which twenty-two were associated with ovarian abscesses, sixteen with tubal tuberculosis, and two with pyosalpinx. In a series of 155 fecal fistulas reported by Mayo and Schliche,<sup>2</sup> twenty-five followed laparotomy for pelvic inflammatory disease. Rankin, Bergen and Buie<sup>3</sup> reported forty-four out of 264 cases of fistulas and Ginzberg<sup>4</sup> reported ten in a series of sixty-two fistulas.

There were forty-two cases of intestinal injury from 1928 to 1943 on the Gynecological Service of Harlem Hospital, where more than 80 per cent of the patients operated upon have some degree of pelvic inflammatory disease. During this period of sixteen years, 5,055 laparotomies were performed. The known incidence of intestinal injury was, therefore, 0.83 per cent.

The intestines may be injured on opening the peritoneal cavity. This type of injury, as a rule, is detected and repaired immediately. Such accidents are more common in patients who have had a previous laparotomy. In this series there was only one such case. No fistula followed. The bowel

may also be lacerated in cutting across the vagina in a total hysterectomy if the rectum is adherent to the posterior wall of the cervix. There was no such accident in this series. Injury to the intestines may also occur in separating adhesions between two loops of bowel, the intestines and pelvic organs, or between the intestines and the abdominal wall.

Two types of adhesions were found, depending upon their origin:

## 1. *Those Caused by Previous Laparotomy.*

In some patients who have had previous laparotomy the intestines and omentum may be firmly matted together with the pelvic organs. These adhesions may be very difficult to separate. In one patient, following a previous laparotomy in which both tubes and the right ovary had been removed, a cystic left ovary was found "cemented" in between the broad ligament and the rectum. Injury to the latter was not recognized and a fecal fistula developed.

In others, the skin, fasciae, peritoneum and intestines may be fused in one thick sheet in which distinct layers or planes are difficult to identify. In cutting through the thinned out fascia and muscle, the peritoneal cavity may be inadvertently opened as a definitive peritoneal layer may be absent. If the intestine is adherent to the abdominal wall it may be readily traumatized. Meticulous dissection on opening the abdomen in a patient who has had a previous laparotomy will prevent intestinal injury.

## 2. *Those Caused by Disease.* Patients with pelvic inflammatory disease of gonor-

\* From the Gynecological Service, Harlem Hospital, New York City.

rheal origin have few adhesions except to the fimbriated end of the tube. The adhesions between the intestines and the tubal wall are usually friable, thin and flimsy and easily separated. At the fimbriated end of the tube where the pus has spilled into the cul-de-sac, the adhesions between the sigmoid, tube and posterior wall of the broad ligament are very dense. Here the separation is usually done blindly (without vision) and the large bowel may easily be injured, an injury which may not be recognized. There were seven such cases of injury in which the sigmoid was densely adherent to a tubo-ovarian abscess or pyosalpinx.

Tubo-ovarian abscesses were present in thirteen patients in this series, four of which were ruptured during the operation. In eleven patients the pelvic viscera and intestines were so adherent that long and difficult dissection was necessary to identify the uterus, tubes, ovaries, intestines and bladder.

Usually the intestinal injury is seen and recognized at the time of operation. There were, however, many cases in which the intestinal trauma ultimately caused necrosis of the bowel, but no injury was recognized at the time of operation. As a result, a fecal fistula or fatal peritonitis occurred postoperatively.

The type of injury to the intestines may be classified as follows: (1) Laceration to the peritoneal coat or serosa and musculature; (2) laceration into the bowel lumen; (3) laceration across the entire diameter of the bowel; (4) internal fistulas (spontaneous) between intestines or appendix and the pelvic viscera, and (5) latent injury not recognized at operation, but later manifesting itself by a fecal fistula or a fatal peritonitis.

In pelvic inflammatory disease of pyogenic or tuberculous origin, in degenerated or infected fibroids, endometriosis, ovarian and tubo-ovarian abscesses, and in malignancies, the adhesions encountered are very dense. In separating these adhesions

to isolate the pelvic structures, the intestines are easily injured.<sup>5</sup>

If patients with pelvic inflammatory conditions are operated upon too early, not only are the adnexae still inflamed, but the intestines are infiltrated, soft and friable. As the acuteness of the infection subsides, the exudate in the intestinal wall is absorbed and the adhesions can be separated more readily.<sup>6</sup>

It is important, therefore, that some criteria be established to determine when the acute infection has subsided.

Falk,<sup>7</sup> quoting statistics of mortality and morbidity of salpingectomy from the literature, found that the mortality rate varied from 1 to 10 per cent. The most important factor resulting in a high mortality was operation during the acute stage. The reports of operative morbidity also varied from 5 to 52 per cent, again determined by the acuteness of the inflammation.

Simpson,<sup>8</sup> in 1907, emphasized the value of deferred operation for the removal of pus tubes. He used the following four criteria to determine the time of operation:

"First, the patient's general health must be such that she has a good margin of reserve strength.

"Second, there must be no cellular exudate. If one existed, it was nature's positive declaration that the offending structure contained a poison she was afraid to admit into her systemic circulation. When the need for its existence disappears, an exudate is always absorbed. We can well afford to wait until that time.

"Third, the temperature must be absolutely normal, or lower, for at least three weeks—at first an arbitrary period, which I think has proven to be the earliest uniformly safe time to operate.

"Fourth, when the preceding have been demonstrated to exist, a careful bimanual examination is made and the temperature is taken every hour for four hours; if this slight traumatism causes a rise in temperature, we may be sure that the greater injury due to the operation would very likely cause a serious inflammatory reaction."

Although Simpson's rules were followed, cases were frequently seen in which despite preoperative bed rest and supportive therapy for as long as two months, extensive exudate and adhesions with friability of the intestinal wall were found at operation. This occurred in spite of an absence of fever or leucocytosis for more than three weeks. It was therefore deemed advisable to add the sedimentation rate of the red blood cells to our criteria.

The Linzenmeir method for determining the erythrocyte sedimentation rate was used. The Linzenmeier values are expressed in the number of minutes required for sedimentation to reach 18 mm. In most other methods the final reading is expressed in millimeters of settling in a standard period of time.<sup>9,10</sup>

Although the normal sedimentation rate is generally considered to be one hour (Linzenmeier method), at Harlem Hospital thirty minutes has been considered the operable index for surgery, particularly in those patients who had been in the hospital for many weeks and appeared clinically ready for surgery.

Of the eighteen cases of fecal fistulas, there were only four cases in which the sedimentation rate was longer than thirty minutes. In nine cases the preoperative sedimentation rate was thirty minutes or less. In the remaining five cases, there was no record of a preoperative sedimentation rate, but the admission sedimentation rate was less than thirty minutes.

The rapid sedimentation rate would seem to indicate a residual acute inflammatory process which cannot be detected clinically.

The forty-two cases of intestinal injury may be divided as follows:

A. Injury detected and repaired during operation—without fecal fistula formation—twenty-two cases.

B. Injury detected and repaired at operation—with the development of fecal fistula—three cases.

C. Injury not detected at operation—with resulting fecal fistula—fifteen cases.

D. Injury not detected at operation—with resulting peritonitis and death—two cases.

A. and B. *Injury detected and repaired during operation—twenty-five cases:* In twenty-five, or 59.5 per cent, of the total number of forty-two cases, injury to the intestines was detected and repaired during operation. The intestinal damage in the twenty-five cases was as follows:

Laceration of the serosa—14

Laceration into the bowel lumen—5

Laceration across the bowel—3

Spontaneous intestinal fistula—3

It is significant that regardless of the type of severity or intestinal injury, neither fecal fistula or peritonitis occurred in twenty-two, or 88 per cent, of the twenty-five cases in which the injury was recognized and repaired at the time of operation. The prognosis in intestinal injury is largely dependent upon this recognition and repair at time of operation. Since unrecognized injury leads to fecal fistula or fatal peritonitis, immediate and proper repair is essential.

In three cases, or 12 per cent, fecal fistulas developed, although the injury to the intestine was discovered and repaired at operation. Two occurred after a serosal tear and one, subsequent to a tear into the lumen of the bowel. The latter was sustained in separating a cystic ovary from between the posterior leaf of the broad ligament and the rectum. Difficult sharp dissection was necessary as the adhesions were particularly dense from a previous bilateral salpingectomy and right oophorectomy. The admission sedimentation rate was only 8 mm. in one hour. Drainage was ample with three Penrose drains to the site of intestinal repair and two to the lumbar gutters with gauze drainage vaginally. Despite low sedimentation rate, adequate repair of intestine and ample drainage, the patient developed a fecal fistula.

C. *Injury not determined at operation—resulting in fecal fistula—fifteen cases:* In

fifteen, or 83 per cent, of the eighteen cases of fecal fistula, intestinal injury was not recognized at operation. In this group, dissection was difficult due to extensive adhesions. Bleeding usually was active and may have been a factor in masking the intestinal injury. No obvious tear or perforation of the intestine was seen. Though no injury was evident at the time of operation, impairment of the blood supply with necrosis of the damaged area resulted in a "blow-out" in the form of a fecal fistula, a fortunate outcome.

*D. Generalized peritonitis following undetected intestinal injury—two cases:* Inclusion of these two cases of a generalized peritonitis makes a total of seventeen cases of unrecognized intestinal injury. Fistula formation did not take place and the leakage of intestinal contents into the peritoneal cavity resulted in generalized peritonitis.

CASE I. D. S. was operated upon for fibromyoma uteri. A supracervical hysterectomy was done with separation of dense adhesions. At autopsy, a perforation of the sigmoid with general peritonitis was found.

CASE II. L. M. had a supravaginal hysterectomy and left salpingectomy. Adhesions between the uterus, adnexa and intestines were separated with difficulty. The abdomen was not drained. On the fourth postoperative day the patient became acutely ill with abdominal distention, rapid pulse and fever. She died on the ninth postoperative day of an overwhelming generalized peritonitis. Post-mortem revealed a generalized fecal peritonitis with three perforations of the small intestine about ten feet above the ileocecal junction.

#### TREATMENT OF INTESTINAL INJURIES AT OPERATION

Repair was accomplished by two to three rows of locked, interrupted or continuous-running sutures of No. 00 chromic or Pagenstecher.

If the serosa alone was lacerated, it was approximated with a continuous No. 00 chromic suture on a fine intestinal needle. When the intestinal wall was infiltrated and thickened, it was necessary to pass

interrupted sutures of No. 00 fine chromic deeply in order to include the submucosa, which is the strongest layer. A second layer of sutures through the serosa was applied following the approximation of the muscular layer. If the injury was down to the lumen, the muscular wall was closed with interrupted sutures followed by two additional layers of sutures. In recent years, 10 Gm. of a sulfonamide were placed into the pelvis and over the repaired area.

In those cases in which the bowel wall is so thick, friable and non-yielding that the edges cannot be brought together, Bonney<sup>11</sup> suggests the following four procedures: (1) Attaching the bowel to the anterior abdominal wall by means of a circular stitch, tying it not too tightly so that the sutures may not tear through the bowel. (2) Suturing the opening in the bowel to the wall of a neighboring coil of gut. (3) Suturing the intestine to the wall of the uterus to close the perforation. (4) Suturing the omentum over the area, being careful not to have too much tension on the transverse colon.

If the large intestine is completely torn across, as occurred in one case, an attempt should be made to do an end-to-end anastomosis. If unsuccessful, a permanent colostomy is established through a stab wound in the left side of the abdomen and the lower loop of the bowel closed.

#### EFFECT OF DRAINAGE FOLLOWING INTESTINAL INJURY

All three cases of fecal fistula which followed intestinal injury were drained. In two, the serosa alone was involved; in the other, there was a small perforation of the intestine. Conversely, in other patients with more extensive trauma, no fecal fistula developed despite lack of drainage.

Of the fifteen cases of fecal fistula following unrecognized injury, nine, or 60 per cent, were drained, six through the abdomen and three by colpotomy.

On the other hand, of twenty-two cases of recognized and repaired intestinal injury

thirteen, or 59 per cent, were drained as follows: abdominal eight, colpotomy three, abdominal and vaginal drainage two. Of the two patients who developed peritonitis, one was drained and one was not.

From the above, it would seem that drainage of any type does not play an important rôle in the prevention of fecal fistulas or peritonitis. Recognition and thorough repair are more important.

#### CLINICAL SIGNS AND DIAGNOSIS

The location of the intestinal fistula determines the symptoms and signs present. The more distal the opening in the intestine is from the duodenum, the less marked are the symptoms and signs. In the low intestinal fistula encountered following gynecological surgery, there is not the loss of pancreatic and intestinal secretion with the marked irritation of the skin caused by the digestive action of the intestinal juices found in high intestinal fistulas.<sup>12</sup>

The prodromal signs of fecal fistulas vary. Abdominal distention and fever usually precede local signs. In most cases there seemed to be, at first, a simple wound infection with, generally, a foul, purulent discharge. The diagnosis was not usually suspected until fecal contents appeared on the dressings.

The presence of *Bacillus coli* in a wound is not sufficient evidence of fecal fistula. In doubtful cases, the oral or rectal introduction of a dye, such as methylene blue, with its subsequent appearance in the discharge from the wound confirmed the diagnosis. An opaque medium, as lipiodal, may be injected into the sinus, a roentgenogram taken, and the fistulous tract thus outlined.

L. H., with a cervico-sigmoid fistula, complained of passing gas through the vagina. The diagnosis was confirmed by a roentgenogram following the injection of lipiodal into the cervical canal.

Internal fistulas, or fistulas between intestines or pelvic viscera and intestines, have been included, though these had

formed spontaneously and were not incurred at operation. They were treated and repaired in the same manner as were the injuries opening into the bowel lumen. There were three such cases, as follows:

1. I. S. Sedimentation rate upon admission was 18 mm. in twelve minutes and 18 mm. in eighteen minutes before operation seven weeks later, though temperature was normal, indicating continued acute inflammation. At operation a large infected ovarian cyst was found, to which the small intestine, sigmoid and omentum were densely adherent. During separation there was escape of pus from the cyst into the peritoneal cavity. The abscess in the wall of the sigmoid which communicated with the infected ovarian cyst was incised and drained and the wound was closed by three layers of interrupted fine chromic catgut sutures. The ovarian cyst was then removed. Eight cigarette drains were inserted, two in each lumbar gutter and four to the cul-de-sac. Infection of the lower half of the wound developed, but this healed and the patient was discharged thirty-four days postoperatively with a small sinus in the lower right angle of the wound. She did not develop a fecal fistula.

2. L. B. The initial sedimentation rate was only 18 mm. in fifty minutes, indicating no acute infection. There were very dense adhesions between the uterus and dermoid cyst and small intestine. These were easily separated. There was a fistulous communication,  $\frac{3}{8}$  of an inch in diameter, between the dermoid cyst and the small intestine. The fistula in the intestine was closed with three layers of fine chromic catgut. Two cigarette drains were placed in the pelvis. Wound infection developed, but the patient was discharged twenty-five days postoperatively with a clean wound. A fecal fistula did not develop.

3. C. H. A right salpingo-oophorectomy and a left salpingectomy and an appendectomy were done for bilateral pyosalpinx and an old appendiceal abscess which was found eroding the ileum. Sedimentation rate was rapid, 22 mm. in fifteen minutes, upon admission. The patient was in the hospital thirty-five days before she was considered ready for surgery. There was a fistulous opening  $1\frac{1}{2}$  cm. in the terminal portion of the ileum communicating with the old appendiceal abscess. There were dense adhesions of the small intestines to the

uterus and the adnexae. The opening in the intestine was repaired by three layers of Pagenstecher. Three Penrose drains were placed in the abdomen. The patient was discharged twenty-five days postoperatively with a clean wound. A fecal fistula did not develop.

#### TREATMENT

*Prophylaxis.* The sedimentation rate seems to be the most reliable test to determine subsidence of infection in pelvic inflammation. As has been pointed out, surgery should be delayed until the sedimentation rate is normal, if possible. Dissection of adhesions in those cases with a rapid sedimentation rate produces bleeding and injury to the bowel. Injury is much less likely to occur, and, if it does, the tissue is not as friable and can be more successfully repaired if there is little or no intestinal exudate. Traumatism in handling the intestines must be avoided with careful use of moist gauze pads and removal of the intestines from the field of operation.

Sharp dissection with scalpel or scissors should be done whenever possible instead of blunt dissection. Where it is difficult to separate dense adhesions between intestines and pelvic viscera, it is best to dissect off a thin shell of the uterine wall or of the ovary or tube and leave it attached to the intestine.<sup>13</sup> In all cases following a difficult dissection, especially where active bleeding occurs, a careful search should be made for possible intestinal injury before the abdomen is closed.

*Treatment of Fecal Fistulas.* The treatment of fecal fistulas low in the intestinal tract, as in the terminal ileum, sigmoid, or rectum, is much less urgent than those located in the duodenum or upper jejunum due to the slight loss of fluids, food and enzymes. Fistulas of the large bowel, or terminal ileum, usually heal spontaneously. Sufficient time should be allowed for the fistulas to close spontaneously before surgery is attempted. Nelson states that these fistulas should not be operated upon for at least a year, as in this period of

time most of them close spontaneously. Treatment is directed toward keeping the wound clean, the skin edges protected and giving the patient adequate care. Dressings should be changed several times daily and the surrounding skin washed with alcohol and covered with zinc oxide ointment, aluminum paste, or a 5 per cent sulfathiazole in a heavy petrolatum base. For the first week following the discovery of a fistula, treatment should be limited to the above until local adhesions have walled off the fistulous tract from the general peritoneal cavity. Saline may be injected into the rectum and drained through the wound and daily irrigations of Dakin's solution may be used in the wound.<sup>14</sup> Warm tub baths daily, the patient remaining in the water for fifteen to thirty minutes, help keep the fistula and the skin of the abdomen clean. Excessive granulation tissue at the mouth of the fistula, or epithelialization of the fistulous tract, may be destroyed with silver nitrate or actual cautery.

The principles of successful closure are thorough exposure of the opening in the bowel, separation from the abdominal wall, complete mobilization and the inversion of the edges of the fistula into the lumen of the bowel. An excision of the fistulous tract with a simple closure of the opening into the bowel may be done. If this is not possible, due to the extensive adhesions of loops of the intestine, a short-circuiting operation between the intestines above and below the fistulous opening may be tried. Most cases require a simple extraperitoneal suture of the intestine.

Two cases were discharged with persistent fecal fistulas; one, L. H., had a cervico-sigmoid fistula and the other, B. Mc., a fecal fistula following a fundectomy and sterilization for advanced pulmonary tuberculosis. She was three months gravid and though there were no intestinal adhesions, the patient developed a fecal fistula of undetermined origin twenty-four days postoperatively.



Three cases had a colostomy performed: E. H., after persistent fecal discharge through three sinus openings for six months postoperatively. The fecal fistulas did not close and the patient died four months later. M. S., forty-one, had a colostomy performed at the original operations as it was necessary to do a resection of the sigmoid which was buried in a solid mass of adhesions filling the pelvis. The friable sigmoid colon tore away and the proximal end was brought through the abdominal wall. The colostomy was closed sixteen months later. Fecal fistulas did not develop. M. S., forty-six, had a colostomy for intestinal obstruction which developed nine days postoperatively. The patient was discharged four months postoperatively and readmitted six months later for closure of colostomy and repair of fistula. Two openings were found in the sigmoid and two in the transverse colon. She was discharged five weeks later, cured.

There were five deaths in forty-two cases, two following a generalized peritonitis without fecal fistulas. Three patients died, apparently, of chronic sepsis associated with fecal fistulas. One, A. B., with operative diagnosis of fibroid and acute salpingitis, had considerable bleeding during dissection of adhesions between uterus, adnexa, bladder and sigmoid. She was discharged five weeks postoperatively, but readmitted ten weeks later with a diagnosis of abscess of the abdominal wall. This was drained and irrigated for two months before a diagnosis of fecal fistula was made. The patient died suddenly six days later. E. R. sustained a laceration of the intestinal serosa in separating adhesions from the adnexae, uterus and intestines. This was repaired and two abdominal drains were inserted. In this case, extensive dissection was necessary to isolate the pelvic viscera. The sedimentation rate was 18 mm. in thirteen minutes on admission and 18 mm. in thirty-four minutes preoperatively seven weeks later. A fecal fistula developed six days postoperatively. She was discharged

with a small sinus in the lower angle of the wound, but was readmitted seven weeks later draining profusely. The wound was revised and a fecal fistula discovered. Despite active local and general treatment, the patient died one month later. Thus, of the eighteen cases of fecal fistulas, three died, one was surgically repaired, and two were discharged with persistent fistulas. The other twelve cases healed spontaneously.

### CONCLUSIONS

1. In a series of 5,055 laparotomies performed at Harlem Hospital on the Gynecological Service, there were forty-two cases of intestinal injury, of which eighteen developed fecal fistulas and two, general peritonitis.

2. The chief predisposing causes of intestinal injury are adhesions and friability of the intestinal wall in pelvic inflammatory disease.

3. The most reliable index of acuteness of pelvic inflammatory disease is the sedimentation rate. A slow sedimentation rate is the chief prophylactic measure against intestinal injury.

4. Where there is a possibility of intestinal injury, diligent examination of the intestines should be made, since recognition and immediate repair is essential.

5. The value of drainage is questionable.

6. In seventeen cases there must have been bowel injury which was not recognized at time of surgery.

7. Fistulas of the sigmoid, rectum, and ileum, the portions of the intestine generally involved in gynecological surgery, usually heal spontaneously within a year.

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RECTOVAGINAL fistula is by far the most common form of vaginal fecal fistula. The possible causes are in the main the same as those concerned in the etiology of urinary fistula. The operations which are most apt to be followed by the development of such a fistula are vaginal puncture for pelvic abscess, perineorrhaphy and hemorrhoidectomy.

From "Textbook of Gynecology" by Emil Novak—2nd ed. (Williams & Wilkins Company).

# PRIMARY TREATMENT OF WAR AMPUTATIONS

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THIS brief report is stimulated by caring for a group of thirty-seven major amputations arriving at a general hospital in the tropics during a recent campaign.

Certain features of primary treatment such as level of and method of amputation and the application of early adequate skin traction are discussed in the hope of improving final results by aiding those men doing primary amputations.

The term "guillotine amputation" has been used to describe the sound expedient method of amputation employed by forward installations of the U. S. Army to diminish the hazard of infection. It appears from this study that the term is misleading in that it implies division of all structures of the extremity at one level with no provision for subsequent closure of the stump. Four thigh amputations in the series had been carried out in a strictly guillotine manner at such a high level that the resulting stumps were poor and the bone length too short to allow re-amputation. It would hence seem advisable to discard the term "guillotine" and use in its place, simply the term "open amputation." The proper concave method of open amputation has been emphasized by Kirk.<sup>1,2</sup>

Thirty-seven major amputations were treated in thirty-five patients with no deaths in the series. Table I shows the

TABLE I  
CAUSATIVE AGENTS IN THIRTY-SEVEN MAJOR  
AMPUTATIONS

| Enemy Missiles | Enemy Missiles and Gas Gangrene | U. S. Missiles | Accidental | Self-inflicted Gunshot Wounds |
|----------------|---------------------------------|----------------|------------|-------------------------------|
| 21             | 1                               | 8              | 6          | 1                             |

agents responsible for the trauma which led to amputation. It is seen that the majority of the injuries were due to enemy missiles. Ten of these were due to mortar shells, six to rifle and machine gun fire and the balance to artillery, mines and grenades. One ankle injury from grenade fragments was amputated below the knee for gas gangrene two days later in an evacuation hospital. This patient received 80,000 Oxford units of penicillin intramuscularly and 1 Gm. of sulfathiazole every four hours for nine days. The patients injured by U. S. missiles resulted from premature explosions, defective shells, errors in range and mistaken identity in battle. The accidental cases were due to vehicles, dynamite and shell explosions.

All the amputations were of the open type and were received with vaseline gauze dressings in place. The wounds, though showing a moderate amount of purulent drainage, all appeared healthy and responded rapidly to Dakinization and supportive systemic treatment of the patient. The patients arrived usually three to ten days after injury. All had markedly reduced hemaglobin estimations of 30 to 50 per cent. All had received tetanus toxoid, blood plasma and sulfathiazole Gm. 1 every four hours prior to arrival here. Half received whole blood transfusions at one or more stages of evacuation and approximately 40 per cent received penicillin 20,000 Oxford units prophylactically every four hours for several days following injury.

Table II shows the sites of amputation and the number in each group. It is seen that there were twice as many amputations of the lower extremity as of the upper and that thigh amputations predominated over all others. During this same period

there were fifteen additional patients with severe amputations of fingers and toes which are not included in this series with the major amputations.

TABLE II  
SITES OF THIRTY-SEVEN AMPUTATIONS

|            | Thigh | Lower Leg | Foot | Upper Arm | Fore-arm | Wrist |
|------------|-------|-----------|------|-----------|----------|-------|
| Upper....  | 5     | 3         |      | 3         | 0        |       |
| Middle.... | 9     | 2         | 1    | 0         | 5        | 2     |
| Lower....  | 2     | 2         |      | 0         | 3        |       |
| Total ..   | 16    | 7         | 1    | 3         | 8        | 2     |

Table III shows that only six patients in the series were admitted with adequate skin traction in place. The healing time was much shorter in these six cases, the treatment simpler and the quality of the resulting stumps better. All patients who did not have early skin traction required freeing of the skin at secondary operation, re-amputation or plastic procedures.

TABLE III  
SKIN TRACTION ON ADMISSION

|                 | No. Cases | Per Cent |
|-----------------|-----------|----------|
| Adequate.....   | 6         | 16       |
| Inadequate..... | 2         | 6        |
| None.....       | 29        | 78       |
| Total.....      | 37        | 100      |

Table IV shows that poor stumps were obtained or forming at the end of the study in eight cases. Seven were due to poor healing resulting from the presence of inadequate soft tissues. None of these seven had skin traction applied prior to

TABLE IV  
RESULTS

|                   | No. Cases | Per Cent |
|-------------------|-----------|----------|
| Satisfactory..... | 29        | 78       |
| Poor.....         | 8         | 22       |
| Total.....        | 37        | 100      |

admission. The eighth poor result occurred in a distal forearm stump which developed a sensitive radial neuroma in spite of good soft tissue healing.

Three of the seven patients had inadequate soft tissues resulting from the severity of the original injury as shown by the field medical records. The remaining four cases were thigh amputations performed in a true guillotine manner at a high level. Though the difficulties of evaluating the true extent of the original injury is appreciated, it seemed that more bone and soft tissue might have been preserved in these cases if its great importance had been appreciated. Adequate skin traction immediately after amputation would have favorably influenced the outcome by preventing soft tissue retraction. It also appeared that the quality of these four stumps was greatly impaired by the division of all structures of the extremity at one level. The proper concave method of open amputation advised by Kirk and McKeever<sup>2</sup> or the short flap method recommended by Orr<sup>3</sup> would have been no more difficult to perform and given excellent soft tissue healing if skin traction had been applied early.

The removal of the whole or major portion of an extremity is crippling surgery and an attitude of conservatism should always prevail. In traumatic and infected cases this is especially true since careful conservative treatment will frequently lead to recovery with a useful extremity. In dealing with the upper extremity, the surgeon should always err in trying to preserve a hand or portion of it as long as possible. Even a thumb and one finger stump may prove to be very useful to the patient.

In war the main indications for amputation are severe explosive injuries which mangle the part, penetrating wounds which divide main arterial trunks as well as accidental crushing injuries. Less frequently severe spreading infection such as gas gangrene which threatens the life of the patient is an indication for amputation.

When a portion of an extremity is no longer viable as manifest by absence of pulse, coldness, color changes and loss



FIG. 1. Wire framework built with padded circular plaster about the arm. Traction produced by rubber tubing through the eyes of the adhesive strips and tied over the end of the frame. Works well for arm or leg.

of sensation, amputation must be resorted to as soon as the general condition of the patient permits. The open method used in time of war is an expedient to diminish the hazard of infection, allow free drainage and diminish the incidence of gas gangrene.

In judging the site of amputation it is highly important to preserve all possible healthy tissue. The skin should be incised parallel with and 1 cm. proximal to the line of demarcation when a line is present. When the amputation is done prior to demarcation, the lowest level at which the tissues bleed freely should be chosen. The fascia and successive layers of healthy muscle should each be divided more proximal than the previous layer down to the bone. It is better to lose a skin edge by cutting too close to the line of demarcation than to sacrifice useful skin covering. However, care must be taken to leave no non-viable deeper tissues. The distance which the bone should be divided higher than the skin incision should vary with

the diameter of the extremity at the site of amputation. For example, the thigh requires approximately three inches of skin to cover the end of the stump while in the arm one and one-half to two inches is sufficient.

Since the primary procedure in an open amputation is not expected to be final, the safest principle is to preserve the greatest length of extremity possible, so that re-amputation can be carried out at the optimum site for prosthesis if necessary.

The method of open amputation advised by Kirk and McKeever<sup>2</sup> is outlined as follows:

1. The skin of the extremity is incised in a circular or oblique manner just proximal to the line of demarcation and allowed to retract.
2. The deep fascia is then incised at the level to which the skin has retracted.
3. The muscles are divided in a concave manner, each layer more proximal than the previous down to the periosteum.
4. Vessels are securely ligated.
5. Nerves are ligated, severed high and allowed to retract without injection.
6. The periosteum is sharply incised about the circumference of the bone.
7. The bone is sawed even with the periosteum leaving no ragged edges. The periosteum is not removed from the tip of the bone.

If all these principles are properly followed and skin traction started immediately after operation, results are excellent since adequate soft tissue is preserved to cover the bone end. Orr<sup>3</sup> favors the fashioning of flaps longer than the bone instead of a straight circumferential incision. The healing of the stumps in this series done by this technic was excellent due to the extra amount of soft tissue present. It is better to err in saving excess rather than insufficient healthy soft tissue providing the wound is kept open and is not permitted to close until all danger of infection has passed.

The value of early skin traction applied to an open amputation stump lies in its prevention of soft tissue retraction. It

slip from the skin due to wound drainage and soiling during the early postoperative period, care must be taken in its applica-

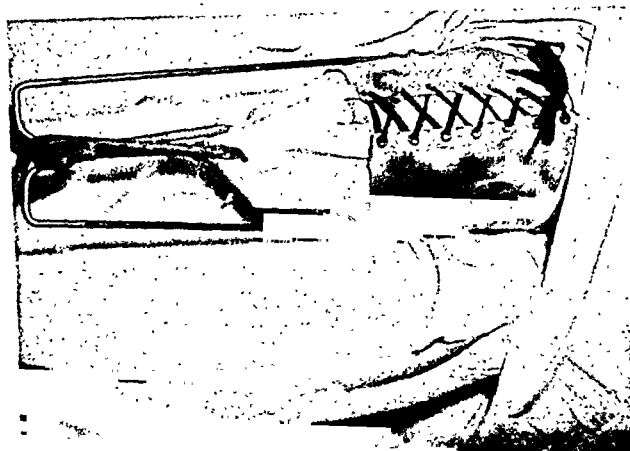


FIG. 2. A light, laced, adjustable leather cuff with wire framework useful in maintaining traction and in making the patient ambulatory.

transforms even a slightly convex stump end to a concave surface with soft tissues drawn down beyond the bone. The size of the wound is diminished and healing time hence shortened. Furthermore the size of the scar at the end of the stump is much smaller, giving a better stump end when re-amputation is not necessary. By keeping the soft tissues drawn down into place, the necessity for re-amputation is diminished.

The effectiveness of skin traction diminishes the later it is applied, due to skin retraction and fixation to subcutaneous tissues. It is, therefore, important to apply traction as early as possible, preferably immediately after operation.

To hold the traction in place during evacuation, an appliance such as that shown in Figure 1 is easy to make and very effective. It is readily constructed with wire, felt and plaster as is self-explanatory in the picture. This type of plaster cuff is comfortable, protects the wound, allows dressings with ease and maintains constant adequate pull on the skin by means of rubber tubing. The tubing from a blood plasma set serves ideally for the purpose.

Since adhesive tape has a tendency to

As in applying Buck's traction strips, thorough cleansing of the skin with ether followed by an adhesive material such as compound tincture of benzoin is important. Four strips of adhesive are sufficient, the width varying with the size of the extremity so that the space between the strips is not over two inches. Two circular strips of the same width should be applied over the others followed by firm bandaging preferably with elastic bandage. This will give sufficient adherence to last six to eight days in spite of dampness, soiling and wound drainage. By this time the patient is usually in a fixed hospital where the adhesive can be changed. A spreader of wire or wood can be inserted later if desired but it is not essential. When the dressing is done, the rubber tubing is untied, and the adhesive strips laid back giving direct access to the wound. The adhesive strips hold the dressing in place when traction is applied making the change of dressings simpler. Stockinet applied with 'Ace Adherent' may be used instead of adhesive tape.

Figure 2 shows an adjustable light leather cuff which has been made at this hospital and which works well. Being lighter it serves well in all stages of

healing and allows the patient to become ambulatory at an earlier time. This improves morale, encourages motion of joints with prevention of stiffness and contractures and diminishes the hazard of pulmonary complications.

#### SUMMARY

1. Thirty-seven major open amputations are discussed.

2. Use of the term "open amputation" in place of the term "guillotine amputation" is recommended.

3. Proper methods of open amputation and the value of skin traction are discussed.

4. Methods of maintaining adequate skin traction during transportation are discussed.

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ONE requisite of a good stump is that the severed muscles receive a new insertion at the stump end. Redundant muscle tissue is useless and makes the stump more difficult to fit and prone to chafe. It is very important that cut ends of muscles or their tendons be grouped about the end of the bone and fixed to the periosteum and fascia or to each other so that they will not retract and leave the bone exposed beneath the skin after healing.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# INTERNAL DERANGEMENTS OF THE KNEE\*

## DIAGNOSIS AND TREATMENT

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**I**NTERNAL derangements of the knee, particularly meniscus injuries, continue to be a timely subject in view of the frequency of this condition among our troops in training. They are, indeed, a most frequent cause of chronic disability of the knee joint, and, despite our highly developed surgical technic, the postoperative results seem too frequently disappointing. Soldiers often reject the suggestion of operation for such derangements because of knowledge of poor results with other patients. The poor results usually derive from incorrect diagnosis or incomplete or late surgery rather than mistaken judgment or the surgical method employed. It is often difficult to make an accurate diagnosis of the type of derangement, and, in all probability, the lesion most often overlooked is a torn posterior segment of the meniscus. In the light of a careful history, a meticulous examination and comparative x-rays of the injured and opposite knees, one may, in most cases, localize the lesion to the proper compartment of the joint and also differentiate cases in which the patients should be conservatively treated.

### MECHANISM OF INJURY

Careful history will indicate that all meniscus injuries result from a rotation-abduction or rotation-adduction strain of the flexed knee. There are apparently two frequent mechanisms whereby these injuries occur. In one, the meniscus is rammed against the femoral condyle by a force directed through the tibia. The usual examples of this mechanism are

those of the runner who is tackled side-wards in football or the runner who, with weight fixed on one foot, pivots suddenly in the opposite direction. In both of these instances, the knee is flexed and the tibia rotated and abducted.

The other mechanism is an analogous force directed through the internally rotating femur. The final phase of normal extension of the knee is accompanied by internal rotation of the femur. The mobility of the menisci varies in individuals and this may explain the susceptibility to injury. Aside from the more marked mobility of the medial meniscus, the frequency of injury of this cartilage may depend upon another anatomic feature. The femoral condyles have a wheel-like action and are set posteriorly in relation to the long axis of the femur, the medial condyle or wheel being larger than the lateral. Although the condyles rotate synchronously in flexion and extension, the rotary arc of the medial is greater than that of the lateral. In the process of extension, when the lateral condyle has come to rest, the medial continues to rotate thus pivoting the femur internally. If, in this final phase of extension, the tibia is fixed in abduction and external rotation, the medial meniscus can be impinged and ground or split beneath the rotating medial condyle. This mechanism occurs in extending the knee rapidly in rising from a crouching position. In marked flexion of the knee, weight is borne far back on the head of the tibia, and a weight bearing rotation strain imposed in this crouching position is

\* This paper was presented at the Tenth Fracture-Orthopedic Conference sponsored by the Air Surgeon at Jefferson Barracks, Missouri, November 19 and 20, 1943. Major Howard G. Weiler, M.C., Chanute Field, Illinois, collaborated in the statistical analysis of the cases reported.



probably responsible for posterior cartilage tears. The relaxed capsule and lateral ligaments escape tearing injuries in these mechanisms.

In this respect, Major Caldwell, writing in the *Military Surgeon*, June, 1943, has recorded certain observations which we have also noted. He reports a striking frequency of degenerative changes of the articular cartilage of the femoral condyles in cases of meniscus injuries. He has recorded his observations statistically, noting about 67 per cent of cases of medial meniscus injuries revealed degenerative changes of the medial condyle. There was a lesser incidence (about 26 per cent) of lateral condylar changes in lateral meniscus injuries. Such changes will not be particularly noted unless they are sought, and will range from only a mild but definite fibrillation to fragmentation or frank osteochondritis dissecans. We noted two cases of osteochondritis dissecans complicating medial meniscus injuries in our group of cases. Caldwell believes these degenerative changes to be due to trauma incident to the mechanical derangement, and in direct ratio to the duration of disability, and apparently not directly related to the severity of the initial trauma. Although not as frequently observed in recent injuries, they will be found in such cases also. It is important to regard the presence of such articular changes as sufficient reason for excision of a meniscus even though it appears normal. Caldwell further states that in every instance in which a normal appearing meniscus was removed, a posterior tear was found.

#### ANALYSIS OF CASES

Without intending this to be a statistical report, we wish, nevertheless, to record certain data upon which our impressions and conclusions are based. In the course of one year from June 1, 1942 to June 30, 1943, several hundred knee cases were examined, over one hundred knee injuries treated conservatively, and sixty-two cases

operated upon for meniscus injuries and two for cysts of the lateral meniscus. We are deleting from this discussion operations for other derangements, diagnosed as other than meniscus injuries. The age range of our patients was from nineteen to thirty-seven years with an average age of 25.7 years. The duration of symptoms extended from four days to thirteen years; and the average duration of disability prior to operation was 3.5 years.

Of these cases, there were forty-one with recurrent or chronic symptoms, and twenty-one with a recent single injury; twenty-five were athletic injuries in civilian life; six were due to industrial accidents in civilian life; three existed prior to induction, but were unrelated to any accident; twenty-eight were service connected injuries, and two were cysts of the lateral meniscus.

They were further analyzed as follows:

- 13—buckethandle tears
- 29—transverse tears
  - 18—were anterior
  - 2—middle
  - 9—posterior
- 12—marginal detachments
  - 6—anterior
  - 1—middle
  - 5—posterior
- 2—longitudinal tears
- 2—hypermobility cartilages
- 2—cases of anterior medial cartilage tears in conjunction with frank osteochondritis dissecans

In addition, there was one patient operated upon for removal of a large loose body in the posterior compartment of the right knee, who had undergone an operation two years previously for removal of a torn medial meniscus. At operation a well formed fibrocartilaginous rim was found to have regenerated in place of the absent meniscus. The regenerated fibrous band measured about 10 mm. in diameter and was firmly adherent to the capsule. It is to be noted that posterior meniscus tears in

the series totaled fourteen, a frequency equivalent to the buckethandle type. Among the complications encountered in this entire group, in conjunction with meniscus injuries, were five cases which revealed anterior cruciate ligament tears, two cases which presented fractures of the anterior tibial spine, and three cases with marked chondromalacia of the patella.

In one case of hypermobile cartilage the only gross disorder to account for locking was a tear of the anterior cruciate ligament. Following removal of the cartilage, the free torn ligament was excised. No repair was done.

Two of the cases presented tears of the lateral meniscus, in addition to severe injury of the medial meniscus, and in each case both cartilages were removed.

One case was a complicated injury in which an extensive tear of the anterior capsule of the joint and the patella ligament laid open the meniscus attachments to the capsule.

Two patients with lateral discoid meniscus gave histories of injury, but in each case diagnosis was established prior to operation by characteristic history and findings.

One patient operated upon for rupture of a medial meniscus of the right knee, and fully recovered, was readmitted five months later with a history of reinjury to the knee. All signs indicated a rupture of the lateral meniscus. Upon failure of the joint to recover by conservative methods, an arthrotomy was performed three weeks after admission, and the lateral meniscus was found completely torn from the posterior and middle capsular attachment. The cartilage was literally coiled in a tight ball in the anterior lateral compartment, and it was removed by simply severing the anterior attachment. Recovery was uneventful and the soldier returned to duty in twenty-nine days.

Hypertrophy of the infrapatellar fat pad was found present in all but eleven cases of long standing disability, and

subtotal excision was done in these instances.

Partial excision of the injured meniscus was done in only three cases, early in the series, of the buckethandle type.

An average of eight days was devoted to preoperative hospital care. In the group of twenty-one recent single injuries operation was done within four days to four weeks of the trauma.

The average postoperative hospital stay was thirty-one days. The shortest stay was fourteen days and the longest stay was 107 days. In this latter case the patient developed a postoperative joint hematoma, and required subsequent knee manipulations for restoration of mobility.

All patients operated upon were returned to duty with the exception of one with a service connected injury, and in whom the meniscus tear was complicated by a tear of the anterior cruciate ligament. After a period of eight months of postoperative observation, this soldier was discharged from the service.

There were no postoperative joint infections. Healing was primary in all but three patients who developed postoperative hematomas; one patient developed a synovial sinus which persisted for fifty-six days; drainage was repeatedly sterile to culture. Two patients developed streptococcus sore throat during the early period of postoperative convalescence, but the wounds healed by primary intention. No sulfa drugs were implanted in the joints or wounds, but forty-three of the patients were given sulfathiazole orally for three to five days postoperatively. The daily dose was 4 Gm. per day. One of the nineteen untreated patients healed by secondary intention following release of a joint hematoma.

Eleven patients required joint aspirations during the early postoperative period for intra-articular hematomas.

Two patients required postoperative knee manipulations for restoration of motion (one with chondromalacia of the patella, one with chronic synovial changes).

Quadriceps recovery was satisfactory in all patients but one, who developed a postoperative hematoma.

At the time of discharge from the hospital, joint motions were, as a rule, restored to complete extension and 75 degree flexion, or better. Only five cases lacked 5 degrees to complete extension, and only six lacked active flexion to beyond 90 degrees.

We do not believe it wise to shorten the hospitalization required before a return to duty status. A minimum of four weeks is needed in most cases for adequate restoration of weight-bearing function.

#### DIAGNOSIS AND CRITERIA FOR OPERATION

There are three general groups of patients with findings indicative of meniscus injuries:

1. Those with a typical history of recent injury and presenting characteristic findings. These are: True locking, in which the joint is locked in semi-flexion, and extension is definitely limited by a rubbery resistance. There is pain and tenderness referred to the site of the torn cartilage. Locking is an especially reliable sign when it is accompanied by a catching sound on forced extension of the joint. Occasionally, it is possible to feel a meniscus slipping in and out of position.

2. Another group of patients presents a history of recurrent episodes of locking with minimal objective findings. These are the so-called latent displacements. Aside from recurrent locking these patients may have other predominant symptoms: a sense of weakness and instability of the joint or periodic synovitis.

3. A third group of patients with a history suggestive of meniscus injury presents persistent symptoms of pain, rather generalized tenderness, and definite limitations of motion; stiffness is the predominant symptom.

The sign of locking itself is not a criterion for diagnosis of a meniscus injury or for operation. Conditions which may simulate

locking are tears of the anterior cruciate ligament, hamstring spasm secondary to minor trauma, flexion of the joint to accommodate increased synovial fluid, thickened synovial folds and hypertrophied fat pad, radiolucent osteochondroma, osteochondritis dissecans, and chondromalacia of the patella.

In the twenty-one fresh injuries of this series locking was a definite symptom and sign in each case; it was also the predominant symptom in forty-three patients of the entire series.

Uncertainty as to the nature of the locking in a recent injury may often be clarified, after aspiration of the joint and a period of bed rest with knee traction. Patients with suspected cartilage injuries should be sent to the hospital at once. We have seen instances in which the torn fragment was displaced into the intercondylar area, and in which apparent complete extension of the injured knee was obtained by manipulation or traction. In such cases, however, careful observation will usually reveal a lack of normal joint hyperextension when compared with its fellow.

In recent injuries, following manipulation or a period of traction at bed rest, when active joint motions have increased, and swelling has subsided, if the cartilage remains displaced a spring-like resistance to extension will persist. When the lesion is an anterior or posterior horn tear, and does not produce persistent locking, a definite diagnosis becomes more difficult. In all recent cases, however, localized tenderness is a constant significant sign and is present in every case of meniscus injury. Tenderness may not indicate the nature or the extent of the tear but will localize the lesion to the proper compartment.

The McMurray or "click test" as described by Watson-Jones is undoubtedly a valuable aid in diagnosing a posterior horn lesion in late cases, but it is our impression that the test is less helpful in recent injuries.

The test is done with the patient supine and the knee fully flexed; the tibia is forcefully rotated inward and outward and also moved sideward in abduction and adduction. The palpating hand on the joint line will note any loose posterior fragment slipping between the femoral condyle and tibial tuberosity, and the resulting click can be localized to either posterior compartment of the joint. If this maneuver does not disclose a typical click, the tibia is then rotated and abducted or adducted in the flexed position, and then slowly extended. A palpable and audible click can then be elicited as the displaced fragment slips between condyle and tuberosity. Captains Slocum and Moore, reporting on the value of this sign, in a recent paper, have recorded the sign as positive in every instance of a posterior meniscus tear in their experience. Posterior meniscus tears, however, are found in cases in which the sign is absent, and it has been noted as positive in buckethandle tears.

In evaluating this sign, it must be remembered that posterior tears exist frequently in conjunction with other cartilage injuries and may occur as second or subsequent injuries. The determination of an injury to the posterior horn is important if one employs a routine surgical approach. The only certainty of dealing properly with a posterior tear is a complete removal of the meniscus; this calls for an adequate approach which does not appear possible by a single anterior incision. We have adopted the practice of resecting the entire meniscus through two incisions in all cases. Only three patients in our series had a partial excision of a torn cartilage, and these were buckethandle tears in early cases.

In the early months of our service we adopted a conservative attitude in dealing with fresh meniscus injuries. This was done in an effort to clarify the diagnosis in many cases, and also to differentiate a peripheral detachment from a substance rupture of the meniscus.

These patients with initial injuries were treated by bed rest with traction, aspiration was done early, and repeated if required, and in many instances manipulations were done prior to application of traction. Following a period of seven to fourteen days in traction, when reduction of a displacement was apparently obtained, the joint was immobilized in a plaster-of-Paris bandage maintaining extension. These patients were returned to duty (usually school) in such support, which was maintained for three to four weeks. During this period of immobilization, they were instructed in quadriceps setting exercises, and, as a rule, following the second week, the support would be bivalved to permit re-examination, local radiant heat therapy and limited active exercises.

Although a statistical follow-up of these patients treated conservatively was interrupted by transfer of personnel, we had sufficient experience upon which to base conclusions. Both from our own experiences with these patients, and our observations of patients conservatively treated elsewhere, we have definitely ruled out such treatment. Non-operative treatment is uncertain, time consuming and invites prolonged incapacity. If the diagnosis is conclusive of a meniscus injury, early excision is the treatment of choice. The time required for conservative treatment is no less than that required for operative treatment. It is reasonable to suppose that many of our patients treated conservatively required operation later at other stations. Although there were as many marginal detachments as buckethandle and posterior tears in our group, the uncertainty of obtaining a reattachment should also exclude conservative treatment.

Even in fresh cases, with characteristic findings, difficulties occasionally arise in evaluating a history. One patient did not recall any injury to the joint but presented typical findings suggestive of a medial meniscus tear. Despite his assertion,

the cartilage was found torn along two-thirds of its length to the tibial attachment and displaced inward. Two patients, with typical findings, claimed the initial symptoms developed during sleep. In dealing with some patients these stories may be viewed with doubt, but cartilage dislocations have been known to occur during sleep. These may have been old injuries with redisplacements.

Another group of patients are those with recurrent symptoms. These patients describe attacks suggestive of redislocations of an injured meniscus. As a rule they present minimal objective findings, but complain of sudden episodes of pain and locking, occurring especially during exercises, or following particular activities. These symptoms may persist for a variable length of time, being of momentary duration, or last up to two weeks. Synovitis may develop with these attacks. During the periods between these attacks, they are comparatively or completely symptom free. If examined at such times, they are apt to be regarded as malingerers. In these cases, conservative treatment will certainly be of no avail. The practice of prescribing knee cages or elastic dressings is to be disparaged. Repeated displacements of a meniscus invite osteoarthritic and synovial changes, and these are often responsible for persistent symptoms after late surgery.

Locking is often not the outstanding symptom. Usually a sense of instability or weakness in the affected knee is the predominant complaint, and is noted particularly in climbing or descending stairs. In this group, the knee has a tendency to give way suddenly when under load in the semi-flexed position, but without actual locking.

Major Stamm, in discussing injuries of the knee joint, at a recent meeting of the British Orthopedic Association, related that in spite of the symptoms, no lesion of the cartilage could generally be found at operation in such cases. He conceded that operation may be justified when

repeated attacks of locking cause severe disablement, but as a general rule it should be avoided for the results are not good. Our experience has been otherwise with patients of this sort, and it may be that total excision of the meniscus may account for a better prognosis.

Total excision of the meniscus is especially indicated in these cases, since repeated episodes do not imply displacement of the same segment. There may be multiple tears. One of our patients, operated upon twice in civilian life for a lateral meniscus injury, complained of persistent pain, instability and a sense of blocking on the lateral aspect of the operated knee. Upon reoperation, at Chanute Field, a large torn posterior segment of the lateral meniscus was removed together with a regenerated anterior portion.

Some of these patients do return with postoperative complaints, but these are usually of a minor nature and may be referred to postoperative knee strain, altered joint mechanics, or quadriceps weakness. The patients who have persistent postoperative complaints are likely to have other pathological conditions in conjunction with meniscus injuries. In the main, they admit marked benefit by operation. To my knowledge, only three patients in the group with persistent preoperative symptoms required reclassification to a Limited Service status. These three patients had persistent symptoms of joint stiffness, pain, and a sense of instability; the objective findings, however, indicated satisfactory postoperative results: motions were of normal range in complete extension, the ligament structures were intact and radiographic studies were negative. Patients with latent meniscus lesions may be regarded as "service aggravated" when the history indicates a fresh injury superimposed in the course of physical training.

The presence of a latent lesion must, of course, be suspected in all cases of recurrent locking, instability, and synovitis of the knee. In determining upon opera-

tion for such soldiers, judgment is influenced by the necessity of returning the patient to a full duty status. Since the diagnosis in these latent cases is made chiefly on the basis of the history, one must be mindful of the conditions which simulate locking; these have already been enumerated.

Patients showing definite arthritic changes in the joints, as evidenced by x-ray study, or clinically, by synovial thickening and restrictions of motions, were not operated upon, since it was believed that this group would not respond sufficiently to be of further use in the service. As a rule, such patients were discharged from the service or retained on Limited Service. But the view that such cases should not be operated upon under other circumstances (non-military) is unreasonable. Following removal of the injured meniscus, thickened fat pads and synovial folds, subsequent muscle training will frequently restore such joints to pain free function. Furthermore, a source of repeated trauma is removed. The difficulty in dealing with this group lies in the differential diagnosis of symptoms as due to meniscus injury or arthritic changes.

#### OPERATIVE TREATMENT

All cases were done under tourniquet control. We have adopted a method of two incisions; one cannot rule out posterior tears through an anterior incision, and we do not believe adequate resection of a complete meniscus is possible through any single anterior incision, except in rare cases of peripheral detachment of the posterior horn or in markedly relaxed joints. Once a joint has been opened for a meniscus injury the entire cartilage should be removed whether the injury can or cannot be seen.

An anterior three inch parapatellar incision is first made, with the knee in extension, allowing an approach to the anterior compartments and an inspection of the condyles, intercondylar area, the

quadriceps pouch, and patella. This incision may be converted into the utility type if necessary.

Depending upon the meniscus to be removed, a posteromedial or lateral incision three inches long is then made, behind and parallel to the lateral ligament, permitting access to the posterior compartment. The knee is then flexed to 90 degrees by lowering the leg end of the table. The cartilage to be removed is then freed at the anterior attachment and along the anterolateral attachments to the capsule. The liberated segment, well gripped, may then be displaced through the posterior incision, and a complete dissection of the posterior attachment is visually possible. In resecting the posterior horn of a lateral cartilage, it is important to avoid damage to the popliteus tendon, for a loosened segment of this tendon might cause locking postoperatively. Adequate surgery requires that the entire cartilage be removed, the thickened fat pads and synovial folds be resected, and any areas of chondromalacia be dealt with by removal of the affected cartilage down to healthy bone. For closure of the wounds the knee is again extended, and this practically approximates the layer edges of the posterior wound.

Considerable effusion must be expected postoperatively. Over a knee dressing and several layers of sheet wadding, extending from upper thigh to above the ankle, a compression flannel or muslin dressing is applied. Finally a posterior plaster-of-Paris splint is incorporated in the muslin dressing to maintain knee extension. The limb is elevated for forty-eight hours following operation, with ice bags about the knee.

Quadriceps muscle exercises are begun on the third postoperative day; patients may be taught the setting exercises in the preoperative period. These exercises are then continued at hourly intervals during the day for five to ten minutes. On the tenth day, dressings and splint are discarded, sutures removed, and active joint

motion initiated. Weight bearing is permitted after the tenth day. The usual patient required four weeks of hospital care, and thereafter most of these patients were granted a convalescent furlough of four weeks, or were returned to a light duty assignment for an equal period. Our observations indicate that these patients usually cannot return to the strenuous physical activity required in military training for a period of about two months postoperatively.

#### CONCLUSIONS

1. In both initial and late cases of meniscus injury, surgery is indicated as soon as diagnosis is determined.
2. Cases with osteoarthritic changes, as evidenced by persistent symptoms and disability, are not suitable subjects for operation in military service.
3. Complete excision of the meniscus should be done in all cases. The method advocated for this purpose requires two

incisions for a visual approach to both joint compartments.

4. Prognosis is generally good. Persistent symptoms postoperatively, which cannot be attributed to altered joint mechanics, knee strain or quadriceps weakness, are usually due to other coexisting pathological conditions, such as early arthritic changes (rheumatoid or osteoarthritic), chronic synovitis or chondritis.

5. Postoperative care includes early quadriceps exercises (after the third day), weight bearing and active exercises after the tenth day, and restriction of strenuous joint activity for about two months postoperatively.

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# ROENTGENOLOGIC EXPLORATION OF SINUS AND FISTULOUS TRACTS

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THE development or persistence of a sinus or fistulous tract is a disconcerting surgical phenomenon. Because the tract may extend through infected adherent tissues and into hollow viscera, and often in many unknown directions, blind surgical exploration is inadvisable. When necessary, surgery is best done after the entire extent of the tract is outlined roentgenographically and its form and directions determined.

Sinus tracts and fistulas are indistinguishable from their surrounding soft tissues since they are of the same density. While these tracts may contain air, the amount is usually insufficient to cast a definitely recognizable shadow. In order to demonstrate the adventitious paths injection of an opaque substance such as lipiodol is necessary. Any other opaque, non-irritating, freely flowing liquid may be used for this purpose.

In civilian practice this method of investigation has been used frequently in cases of biliary fistulas. In this hospital most of the tracts injected were secondary to gunshot wounds. Multiple lacerations of the bowel, secondarily infected fractures, or those in which sequestra had formed, were frequent sources of sinus tracts.

The injection should always be made under fluoroscopic control, since the form, direction, depth and capacity of the tracts are usually unknown. It is almost impossible to predict the site of origin of a sinus, or to indicate which of many metallic fragments is the offending irritating locus. The external opening is indicated by attaching an opaque marker to the skin with adhesive tape. Depending upon the size of the opening, a catheter, cannula, blunt needle or even the nozzle of the glass

syringe may be inserted into the sinus opening. If the injection is made slowly and without undue pressure, leakage is often avoided. Spot films may be made at intervals during the injection. Usually however, the films made in various projections with the over-the-table tube and the grid diaphragm will show everything necessary for the proper interpretation of the case. Care is taken to wipe off any spill-over of the opaque fluid onto the skin before taking the films in order to avoid confusing shadows.

This procedure may be done with safety as soon as the general condition of the patient permits manipulation. Gross infection is no contraindication since injection to the point of overdistention is never performed. In small closed tracts the injection is stopped when the patient complains of pain. Usually the tract will decompress itself by expelling the oil along the catheter before pain is experienced. Another film of the area is often made from twelve to twenty-four hours later. During this time, seepage may outline other pockets or connections with viscera which were not shown during the original examination. It may also be desirable to show how effectively a cavity drains itself.

Almost all sinuses which persisted in draining or which recurred after closure were examined.

The following examples are cited to indicate the complexity of the cases and the valuable information obtained with this procedure:

## CASE REPORTS

CASE I. This patient was admitted with the residuals of a penetrating abdominal



wound in which the wound of entrance was in the midline in the sacrococcygeal region and the exit in the left upper quadrant. He had

entered the knee joint. A pyoarthrosis developed with resulting ankylosis. A draining sinus persisted at the site of the original bullet



FIG. 1. CASE I. A small sinus tract resembling a pilonidal sinus situated at the level of the sacrococcygeal junction was injected with lipiodol. The oil entered a small pocket and thence the left ureter. A few globules entered the lowermost calyx. The patient had had dysuria, but no leakage of urine from the sinus opening.

incurred multiple injuries of the bowel and bladder.

On admission he complained of pain in the coccygeal area and severe dysuria and tenesmus. A double-barrel colostomy was present in the left side of the abdomen. A small sinus was present in the coccygeal region, simulating a pilonidal sinus. His urine was cloudy with numerous white cells.

The sinus tract was injected with lipiodol, demonstrating a connection with the lowermost portion of the left ureter.

CASE II. A bullet produced an oblique fracture of the distal end of the femur which

wound. An examination of the knee showed the ankylosis, but failed to demonstrate any reason for the persistence of the drainage. Injection of lipiodol showed the tract to enter a small cavity in the knee joint. Curettage of the sinus tract and the small cavity resulted in healing.

CASE III. In the course of septicemia, this patient developed multiple abdominal abscesses. One of these located in the pelvis was drained, but soon after began to discharge fecal material. Because this persisted, the tract was injected with lipiodol. An irregular branching sinus was outlined which appeared to enter the large bowel. A small amount of barium

suspension injected per rectum was seen to meet the iodized oil in the sigmoid. Methylene blue injected into the tract was recovered in

the crest of the left ilium, with separation of a small fragment of bone. A diplegia resulted. A sinus tract which drained persistently from the

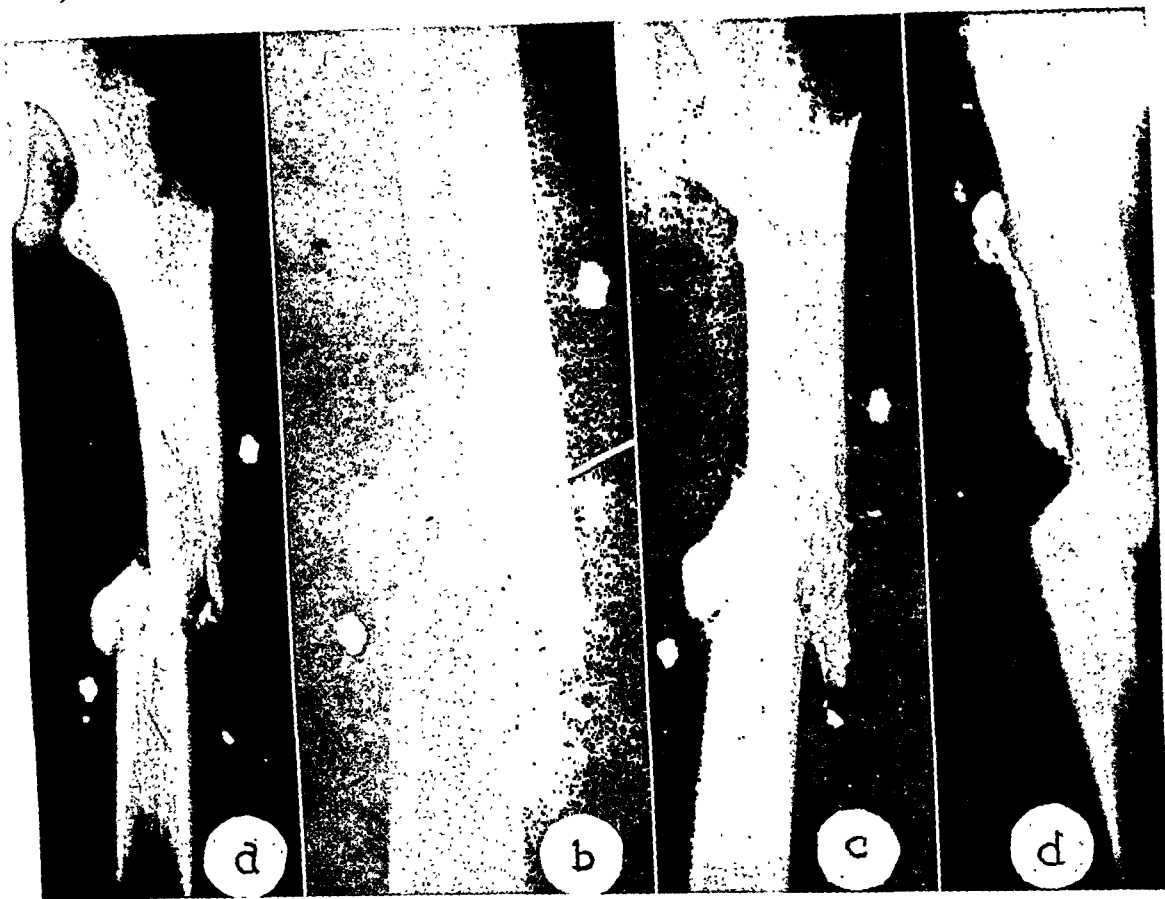


FIG. 2. CASE VII. A draining sinus persisted at the lateral aspect of the fracture site. Since there was no demonstrable osteomyelitis one of the metal fragments was suspected of being the cause. (a), a probe inserted down to the bone did not approach any of the fragments; (b) spot film. As a last resort lipiodol was injected; the oil flowed to the metal fragment least suspected (c and d).

the feces. This sinus tract could not be demonstrated at autopsy two months later.

CASE IV. Multiple high explosive wounds about the lower abdomen resulted in deposition of many large metal fragments and a draining sinus in the right buttock and another in the right pararectal region. The problem was to demonstrate both tracts and to determine, if possible, communications of the sinuses with the bowel or with each other. The gluteal sinus ended blindly at a large metal fragment. The pararectal sinus entered the rectum; the two sinus tracts did not communicate with each other.

CASE V. A burst of machine gun bullets traversed the body of this patient from right to left at the level of the iliac crests, smashing the bodies of lumbar 3 and lumbar 4 and fracturing

left side was thought to be due to the loose fragment of the crest of the ilium.

A catheter inserted into the sinus reached the fractured vertebrae. The lipiodol passed through a tunnel in the vertebral column to reach a large pocket on the right side of the abdomen. This communicated with the ascending colon on its posterior aspect about 3 inches above the ileocecal junction.

CASE VI. A colectomy was performed on this patient for colonic polyposis with malignant degeneration. He became infected, very toxic and drained profusely from an opening near a right lower quadrant ileostomy, which was thought to communicate with the small bowel. Injection with lipiodol revealed the sinus to extend into a large abscess cavity which coursed along the left paravertebral gutter.

There was no communication with the small bowel.

CASE VII. This patient sustained a compound fracture of his femur when an anti-aircraft shell exploded in his cockpit. Many small metal fragments became imbedded in his thigh. (Fig. 2A.) Drainage persisted from a large laceration over the fracture site. There was no roentgenographic evidence of osteomyelitis. A metal probe inserted down to the bone failed to approach any of the metal fragments. (FIG. 2B.) Lipiodol injection showed the surprising extent of the tract; it ran to the fragment farthest removed. (Fig. 2C and D.) The offending fragment was removed and the sinus tract healed.

#### COMMENT

Draining sinuses are too often treated by non-interference, when a detailed investigation might easily lead to the discovery of a remediable lesion and hence to cessation of drainage and the closure of the sinus.

By the time the patients reach this General Hospital most of the metallic foreign bodies which are present in the gunshot cases are of importance only in

their significant relationship to a continued draining sinus. None of our patients has suffered any ill effect from such an examination. Even the slight inconvenience caused the severely ill patients is of little consequence when the eradication of the source of prolonged debilitating drainage is the result.

#### CONCLUSIONS

1. As has been demonstrated, the site of origin of the sinus tract cannot be determined roentgenologically without the aid of an opaque medium.
2. The site of the opening gives no indication of the location of the major portion of the adventitious cavity nor of the direction or number of its tracts.
3. The ease with which the examination can be done, the valuable information which may be obtained, and the almost complete absence of contraindication serve to indicate that every wound in which healing is not soon established, or which drains persistently, should have the benefit of this method of investigation.



# REFRIGERATION ANESTHESIA\*

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THE use of cold as a therapeutic agent is as old as medicine. Ice applications and cold compresses for the relief of pain and for the reduction of inflammation have been used for many centuries. Within recent years, however, newer concepts of refrigeration have been developed. The familiar work of Fay<sup>12</sup> and his associates, in reducing temperatures over long periods of time in patients suffering from cancer, emphasized that a lower metabolic state, comparable to hibernation in lower animals, is possible in human beings. Whatever the value of these studies so far as any positive attack on the broad field of malignancy is concerned, they pointedly demonstrate that tissue metabolism can be slowed to a degree hitherto not thought possible. A more recent development, and the one that this paper is particularly concerned in describing, has been prompted by the observations of Allen<sup>1,2,8,10</sup> on the use of refrigeration in diabetic or arteriosclerotic gangrene or both.

For some time it has been known that tissues can be kept alive for many days at icebox temperature provided they are not frozen. In experiments, Allen<sup>13</sup> has demonstrated that the cooling of limbs or other parts with ice water or ice, cracked or pulverized, down to near the freezing point, say five degrees Centigrade (40°F.), is harmless. There is a temporary suspension of life, with resumption of cellular activity as the temperature returns to normal. In refrigeration of limbs for anesthetic purposes, complete stoppage of circulation is effected by careful application of the tourniquet. This, in brief, is refrigeration anesthesia, which becomes complete after one to two hours. Needless to say, freezing must be avoided.

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## EXPERIMENTAL EVIDENCE

It has been shown by Fay<sup>12</sup> and his workers that irritation, heat and pain produce hyperemia in the segmental area of stimulation, conversely, cold produces vasoconstriction and hyperemia in the same neurological reflex arc. He showed that cold reduces the pain that is due to malignancy.

There is ample evidence that when the extremities of animals become totally ischemic as the result of deprivation of blood supply by a tourniquet, exposure to room temperature or to an increased temperature results in rapidly progressive tissue necrosis. It has further been observed that the reduction of temperature enables limbs to survive for a much longer period of time. Brooks and Duncan,<sup>14</sup> for example, noted that a rat's tail became gangrenous within four hours after ligation at a temperature of 40°C. When, however, the temperature was reduced to approximately 5°C., the survival period was extended to as long as four days. Allen<sup>20</sup> observed that the hind legs of rabbits, cats and dogs survive asphyxia for thirteen or fifteen hours at room temperature. When the temperature is reduced and maintained at approximately 2 to 4°C. the dangers of ligation are greatly diminished. Under these conditions, limbs showed a survival period of fifty hours or longer. Furthermore, the phenomena of shock, thrombosis, infection and injury to blood vessels and nerves were markedly inhibited.

## PHYSIOLOGY AND PATHOLOGY.

The lowering of temperature to a level slightly above freezing produced anesthesia by stopping cellular metabolic

processes. It puts the cells at absolute rest in a manner comparable to hibernation. Inactive cells will not respond to stimuli. It is a matter of elementary knowledge that plants and protozoa without nervous systems exhibit chemical protoplasmic reactions to injury. Equally familiar is the fact that operations under any known anesthetic are productive of shock in proportion to the duration and degree of tissue trauma. Mitigation of this recognized harm has been sought only through speed and delicate precision of the skilled operator. Crile had a true vision in his anoci-association, but refrigeration alone inhibits all protoplasmic activity, including the shock response.

Life processes, in common with chemical reactions, have a speed which is profoundly influenced by temperature. Oxygen consumption of the tissues can be reduced about 13 per cent for each degree Centigrade that the tissue temperature is reduced. When a tourniquet is applied and the extremity is packed in ordinary chipped ice (without salt) the oxygen demands are reduced sufficiently to prevent necrosis for many hours. The skin temperature falls to between 2 and 4°C. and surgical anesthesia is complete in about two hours.

It has been definitely shown that heat accelerates necrosis, whereas cold markedly prolongs the survival time of anemic tissues. Allen made the first clinical application of these laboratory observations in cases of arteriosclerotic gangrene of the leg. Subsequently, the value of refrigeration in arteriosclerotic gangrene and in limb sepsis and trauma has been repeatedly confirmed by observers who have made the clinical trial. In all these cases there has been a deficient circulation in the limb. Very few observers have claimed merit for refrigeration when normal circulation is present. The tissues are able to handle traumatic or septic conditions better with the aid of their normal physiologic inflammatory reaction than by suppression of this reaction by

refrigeration. There is increased exudate, increased absorption and increased local heating of tissues with accelerated tissue metabolism which is beneficial as a normal inflammatory reaction. There is also a greatly increased tissue demand for oxygen at the same time which is out of proportion to the increased local blood flow. In a limb with deficient circulation, a disparity may exist between the supply and the demand for oxygen on the part of the tissue cells. As a result of this, the necrosis of tissue may occur if the inflammatory response is augmented by heat. The application of cold to such tissues is beneficial because it retards the oxygen demand of the tissues to a level commensurate with the available oxygen that is brought to the limb by the deficient circulation.

#### ADVANTAGES

The principal benefit resulting from refrigeration is the lowered metabolism of the tissues and the resulting lessening of the oxygen demand. There is also efficient anesthesia secured by the action of refrigeration of nerve trunks and also by what Allen terms as "anesthesia of protoplasm." Nerve impulses are abolished. Also, one of the fundamental properties of protoplasm is irritability, but this and all other living activities are arrested by cold.

*Relief of Pain.* The immediate salutary effect of chilling of tissues on the more prominent signs and symptoms was most striking. Relief of pain was observed in every case and without the aid of the customary medication. It is well known that cases of sudden arterial occlusions, as from embolism, are most painful and that great discomfort persists for many hours after the initial obstruction. It was in this group that the relief of pain is most dramatic.

*Shock.* Shock has always been an outstanding and disturbing feature of thigh amputation, both during and after operation. In addition to operative trauma,

general and spinal anesthesia, particularly the latter with its frequent attendant fall in blood pressure, contribute greatly to secondary surgical shock. This phenomenon is not observed with refrigeration anesthesia. There is little if any pulse or blood pressure change. Shock is non-existent except for the (usually slight) degree of it which may develop from the tissue injury remaining after the wound is finally closed and the temperature is raised to allow the protoplasm to resume its functions. This explains why a reasonably strong patient, after a thigh amputation by this method, can immediately return to the ward and eat a full meal as though nothing had happened, and, in general, why this anesthesia offers a radically new approach to the idea of accomplishing an operation while maintaining a constitutional condition as if there had been no operation. Since shock is non-existent, the duration and degree of tissue trauma are immaterial, and the essential factor is the state of the wound when normal temperature and blood flow are restored. Anesthesia of protoplasm, in contrast to nerve anesthesia, is said to be a factor in preventing shock; shock is also lessened by the diminished tissue necrosis, diminished bacterial growth and the diminished absorption from the local site because of the vasoconstriction brought about by refrigeration.

*Infection and Edema.* There is marked inhibition of infection and edema. This is in line with the familiar preservation of tissues in an icebox for days or weeks. Tissue devitalization, infection and shock are inhibited in proportion to the degree of reduction of temperature.<sup>13</sup> The progress of gangrene and sepsis is markedly inhibited by the application of cold. In these cases a tourniquet and refrigeration can be applied for as long as twelve hours or longer without progress of infection or gangrene and with first intention healing following amputation. However, reduction in temperature does not avert amputation when devitalization of a part has once

occurred. It has been interesting to observe that when gangrenous limbs are exposed to ordinary room temperatures after refrigeration, gangrene progresses rapidly. A return to decreased temperature slows the process. The preservation of tissue vitality, the bacteriostatic action of cold and perhaps the high oxygenation of the blood and tissue fluids may explain the noticeably high resistance to infection in these cases. It has been shown many times with refrigeration anesthesia, that amputations at mid-thigh levels or higher, with the cutting of large muscle masses, are not necessary since recovery has been obtained following amputations at lower levels, even when lymphangitis or actual pus extended far above the incision. This success has been obtained both with and without sulfonamide drugs. This may be credited to refrigeration, but probably the drugs will be used as a routine in such cases.

Edema may be detrimental because of tension on sutures, by furnishing a culture medium for bacteria and especially because of pressure on an already feeble capillary circulation. It has been effectively checked by cold.

*Healing.* Most wounds from refrigeration amputation when tightly closed heal *per primam*, and the percentage of first intention healings is comparable to that after similar operations done under other anesthetics.<sup>3</sup> It has been emphasized, however, that refrigerated incisions heal more slowly than others, because of the known tendency of cold to inhibit agglutination of wound surfaces as well as an arrest of all other healing processes. Therefore, instead of the usual alternatives of prompt primary union or a breakdown followed by granulation, the surgeon encounters a new phenomenon, namely, a wound healing strictly *per primam* but requiring a multiple of the usual time. The skin sutures must not be removed until after the fifteenth or twentieth day.<sup>11</sup> It is impossible to force an activity of tissue beyond the limit set by its blood supply. Raising the temperature of the stump as rapidly as

possible promotes rapid healing, but this is not justifiable because of the risk of incurring sloughs. Slow healing is better than no healing at all. Postoperative wound drainage is usually more profuse, since refrigeration inhibits the agglutination of the wound margins. It has been observed that a raise in postoperative temperature after an amputation performed under refrigeration anesthesia is not as prolonged as after amputation under spinal anesthesia.

#### INDICATIONS

Broadly speaking, refrigeration therapy has been advocated for three types of surgical lesions of the extremities: peripheral vascular disease with circulatory insufficiency, uncontrollable limb sepsis and severe trauma of the limbs with circulatory impairment. Arteriosclerotic gangrene has been the most frequent lesion in which refrigeration anesthesia has been used. Two distinct types of patients have been treated. When amputation is inevitable in non-toxic patients in poor general condition, the application of a tourniquet and refrigeration have provided a quick, satisfactory anesthesia within several hours, accompanied by minimal reaction to the operative procedure. On the other hand, if spreading sepsis predominates in the arteriosclerotic limb, permanent and continuous refrigeration may be employed for a period of days while the general condition is being improved.

There are many cases of early gangrene of the toes or a part of the foot due to peripheral vascular disease, especially among diabetic patients, in which a high amputation seems entirely too radical to the patient or to his relatives and consent is refused. Partial refrigeration of such an extremity, that is, chilling it by surrounding it with ice bags or cracked ice without the use of a tourniquet, has proved to be of therapeutic value. The metabolism in the extremity is retarded to the point that the gangrene may be checked and collateral circulation may have time to become

established.<sup>4</sup> Richards doubts if any collateral circulation can be obtained by refrigeration.<sup>21</sup> If infection is present, this partial refrigeration inhibits bacterial growth, thus eliminating the spread of the infection. This method, especially when combined with the treatment of the peripheral vascular disease and the control of the diabetes, if present, may prove of the greatest value in limiting many amputations to the local area of gangrene or at least to the lower extremity instead of the routine thigh amputation as practiced by the majority.

Frequently, diabetic or arteriosclerotic patients have been so debilitated or so weakened by sepsis that they were poor operative risks. Many of them, sorely in need of amputation, have been allowed to die because experience and judgment warned against operation. Others have been so badly infected that their lives could be saved only by ridding them of the infected member. In these cases it has been the custom, in the past, to do a quick guillotine amputation in the calf, intending, if the patient survived, to do a finished amputation later, above the knee. Many of these stumps became infected, frequently with the gas bacillus. The patient frequently may go into diabetic coma or develop a generalized sepsis and die in spite of all therapy. It is in such cases that the tourniquet and refrigeration have been particularly valuable. The tourniquet stops absorption, while refrigeration inhibits cellular metabolism and retards bacterial action. Preoperative treatment is then of some benefit. A finished amputation at a site of election can then be done without much fear of stump infection. The absence of shock gives the patient a better chance to survive.

If the infection is very severe and threatening the life of the patient, the tourniquet may be placed above the site of infection and the part refrigerated for hours or even days. The simple packing in ice will often transform both local and general conditions and may check pain and the advance of

sepsis for perhaps several days.<sup>4</sup> When necessary, the tourniquet can give a still more decisive result, obviating the need for morphine and the waste of time and strength in preparing for operation. If applied promptly by anybody on the resident staff, it will within a few hours permit an amputation without other anesthesia and with minimal shock. If the condition is so extreme as to make any operation inadvisable, the limb can be left for a few days or can be harmlessly amputated or disarticulated anywhere below the tourniquet in order to reduce the mass to be kept refrigerated. Later, when the patient's condition is improved to the point of standing an amputation, a second tourniquet may be applied about the thigh and refrigeration carried this high for two and one-half or more hours and the extremity removed. If this technic is carried out, the first tourniquet must never be removed.

Refrigeration offers advantages for nearly all cases of severe wounds of the extremities. Prevention and treatment of shock may be sufficient indications; surgical anesthesia is a valuable by-product. The suffering and blood loss from periodic loosening of an emergency tourniquet can now usually be avoided. Certainly, external applications of heat should never be used in conjunction with a tourniquet. Simple measures can and always should be instituted to help cooling whenever a tourniquet is applied. This is especially important in hot environments. Refrigeration anesthesia undoubtedly is destined to increasing use under civilian conditions as well as in war. In trauma of the limbs, for instance, which is common in war, refrigeration anesthesia may be of special service, not only in amputation, but also in the control of hemorrhage, pain, progressive shock and infection during transportation of the patient when adequate treatment cannot be applied on the spot. The methods of refrigeration anesthesia are being standardized. In the New York

City Hospital a controllable electric refrigeration apparatus is in use.<sup>2</sup>

In badly crushed extremities, shock, often of an extreme degree, is present as the result of hemorrhage and absorption of histotoxins from crushed tissues. When a limb is so crushed that amputation is inevitable, the immediate application of a tourniquet and the packing of the limb in ice is advised.<sup>4</sup> This checks the shock and retards bacterial growth. It permits the surgeon a few hours to give the patient a transfusion and otherwise prepare him for amputation. Finally, the amputation can be performed without shock and without any other anesthetic agent whatever. McElvenny<sup>23</sup> reported a case of traumatic amputation in which ice was used pre-operatively for fifty-eight hours without a tourniquet. The patient survived a bilateral thigh amputation.

*Military Wounds.* Allen and Crossman<sup>15</sup> have stated that tourniquet refrigeration provides freedom from pain, hemorrhage, shock and infection and allows either an immediate operation without other anesthesia or long deferment of operation without harm, if such a step is indicated. It is emphasized that the safe period for the application of the tourniquet is greatly lengthened by refrigeration. Refrigeration is usually available on naval vessels, and a 200-pound apparatus can be operated by the motor of a truck which will refrigerate four to six limbs simultaneously.<sup>11</sup> Bowers<sup>16</sup> has related favorable experiences in the treatment of patients with vascular trauma of the extremities encountered in a station hospital. He found the fluorescein circulation time test to be of value in the estimation of circulatory adequacy in refrigerated limbs. Criteria of failure of compensatory collateral circulation were listed.

*Miscellaneous.* Holman<sup>17</sup> suggests that in cases of limb trauma accompanied by concussion of the main artery with subsequent segmental arterial spasm, initial refrigeration enhances the survival of such a limb. In the immersion-foot syn-



drome, the principle of refrigeration has been employed to provide therapeutic cooling of hyperemic painful feet during the early stages. Such cooling without actual refrigeration has also been found useful in cases of frostbite.

Refrigeration anesthesia for skin grafting opens a new field for the use of reduced temperature in surgery. Mock<sup>18</sup> reported twenty-seven cases requiring small or multiple small split thickness skin grafts in which this method was used. Pinch grafts could be removed equally well, although none were attempted in his series. His results were reported as very satisfactory.

#### TOURNIQUET

The use of a tourniquet is one of the great controversies in medicine. Most objections have centered about three points: The local asphyxia of the tissue distal to the tourniquet, the damage to the tissues compressed by the tourniquet and the shock produced by the release of the tourniquet. While there has been insufficient investigation to establish or refute these objections definitely, animal experiments have shown that bloodless extremities can survive twelve to fifteen hours at room temperature, without necrosis.<sup>10</sup> Crössman, Allen<sup>19</sup> and their co-workers reported one badly ulcerated human leg that had a tourniquet applied for six hours without apparent damage. Several days later this leg was amputated and pathologic examination likewise failed to demonstrate any damage from the six hours asphyxia. Direct pressure does injure tissues. The amount of damage depends on the tension, the elasticity and the width of the tourniquet. Naturally, only sufficient tension should be applied to stop the flow of blood. Elastic materials are less harmful than cords or other materials that will not expand. Except in the arm, where there are many nerves without much tissue padding, a narrow zone of constriction is preferable. Serious systemic shock has been produced by the release of a tour-

niquet that has rendered large masses of tissue bloodless for a long time. The histotoxins that form in asphyxiated tissues during the usual time a tourniquet is in place are insufficient to do this.<sup>4</sup> Badly traumatized tissues that have impaired local resistance are an exception. Here a tourniquet must be used guardedly unless it is in conjunction with refrigeration. Reduced temperatures obviate all the objections to tourniquets because the compressed or asphyxiated cells are at rest and are not throwing off waste products.<sup>10</sup>

The material for a tourniquet should be most elastic pure rubber tubing and the width should be the narrowest possible (perhaps 1.25 cm.),<sup>2</sup> because the wide bands in common use do not reduce the pressure needed at any one point but merely widen the zone of possible injury. Allen<sup>2</sup> and others state that the tightness must be sufficient to stop all flow of blood. In experiments, excessive tightness has proved to increase damage and danger, but there are no means of measuring the tension. It has been necessary that the errors should be on the side of excess and there has as yet been no clinical complication from this cause. The grossly exaggerated fears which prevail concerning the tourniquet have doubtless been due to the use of excessively tight, broad, inelastic bands, aggravated sometimes by elevated temperature.

These causes explain most of the unfavorable clinical effects attributed to tourniquets, such as paralysis, contractions, atrophies and tissue devitalization. There is reason to believe that a human limb can survive the stoppage of blood supply for as long a time as an animal's leg, namely twelve hours or more at ordinary temperatures.<sup>2</sup> After such a long period paralysis is inevitable, but it is transitory if the tourniquet has been properly applied, and the sequelae mentioned do not occur. This high resistance of a sound limb does not prove absence of injury. After such long asphyxia the

secondary inflammation is severe, and weak points such as recently healed wounds or tissues in the grasp of the tourniquet may break down. Even with shorter asphyxia, fresh wounds and infection create a highly dangerous complication, so that the devitalization may then be sufficient to threaten loss of the limb or even of life. The danger of constitutional shock increases with the mass of tissue ligated and the duration.<sup>1,2,10</sup> Therefore, these complications combine with the previously mentioned mistakes to give the tourniquet its bad reputation. In practical surgery there are two ways of avoiding these complications while obtaining the benefits of the tourniquet. One method has been emphasized especially by Crossman,<sup>10</sup> namely, a permanent tight tourniquet can be placed on a limb which is known to require amputation. The patient can thus be spared pain, hemorrhage, shock and infections, and the limb can be removed at or above the tourniquet whenever the care of a surgeon is obtainable. The decomposition of the part below the tourniquet does not endanger the patient, so long as the tourniquet remains tightly in place.

The tourniquet consists of two turns of a rubber tube to create the narrowest possible zone of compression. The clamp holding the two ends is kept from pressing on the skin by means of a gauze pad. Correct application of the tourniquet is one of the important details. As has been stated, empirical judgment has thus far been the only guide for the degree of tension, which should be the least that will positively stop all blood flow. Therefore, in some arteriosclerotic cases or in shock, this tension may be less than in the normal and much less than in a hypertensive patient. The rule that a tourniquet must not be applied to a diabetic or arteriosclerotic limb has been set aside by cold.<sup>1</sup> Just as the vessels of normal animals can tolerate a tourniquet for a day or two, so also the clinical experience thus far has shown no signs of serious or

lasting damage to the most arteriosclerotic diabetic vessels by constriction up to five hours at a temperature near freezing.<sup>1</sup> But as excessively tight ligations produce ulcerations, paralysis and thrombosis in animals, similar consequences may reasonably be expected in humans. The practical experience indicates, however, that the margin of safety for these comparatively brief periods of only a few hours in patients, is so wide that there need be no extreme fear in applying a tourniquet with any reasonable care.<sup>10</sup>

#### REFRIGERATION

The first clinical employment copied the procedure used in animals, by having the patient sitting up or propped up at a sufficient angle to allow the leg to be immersed in ice water to a level about one inch above the tourniquet. The advantages of this method were that the cold was maximal, reached every part of the skin and yet could not freeze the tissues. Next, weaker patients were allowed to lie with only a slight elevation of the head of the bed, and with the protection of a rubber sheet, the leg or thigh was placed on a layer of ice and covered completely with cracked ice. To obviate inconvenience and mess, a third step was taken by using ice bags. The thinnest and most flexible pure gum bags should be used, and three to five teaspoonfuls of salt added to each.

It has been suggested that the limb be first surrounded with a few ice bags at the level chosen for the tourniquet. Within five to fifteen minutes the skin is chilled so that the application of the tourniquet may cause scarcely any discomfort. If the limb contains any important amount of non-infected blood, it may be elevated to drain out as much as possible and the tourniquet applied while it is vertical. Immediately thereafter, the limb is completely buried in ice bags or cracked ice to a level several inches above the tourniquet. Any pain or discomfort quickly subsides under the influence of cold. A preliminary morphine hypodermic or other

sedative may be helpful on account of nervousness in some patients; but as far as anesthesia is concerned, no drugs are required. Whiskey is a good sedative for elderly arteriosclerotic patients.

Tests of the refrigeration should be made by occasionally inserting an ordinary laboratory thermometer between the various ice bags and the skin. Readings slightly above or below 5°C. assure the desired combination of adequate chilling and safety against actual freezing. A simple special apparatus for this purpose may be used but the use of ice or ice bags will permit of trials in any hospital or even under makeshift emergency conditions.

#### ANESTHESIA

It has been noted that the time required for complete through-and-through anesthesia varies with the depth of tissue. It may possibly be as short as one hour for an emaciated shin or as long as five hours for a rather thick thigh. If it is not possible to cut the sciatic nerve at mid-thigh without attracting the notice of the conscious patient and without any change in pulse or blood pressure, there has been something wrong in the method of preparation. This physiological blocking of nerve conduction by reduction of temperature has some evident advantages over drugs employed either locally or systemically for this purpose.

#### OPERATION

It is assumed that the tourniquet has been placed at the lowest level which will permit of preparing a sterile operative field and also not impede the sawing of the bone or other procedures. In the operating room the limb is removed from its nest of ice bags or cracked ice and the sterilization and operation completed as usual. No extraordinary haste is demanded, because the chilled tissues remain cold during an ample time for an ordinary operation. A rise of temperature does not affect the anesthesia, which is still thoroughly maintained by anoxia, but it is

inimical to the perfect preservation of tissues and avoidance of subsequent shock. If saline solution is to be used for sponging or other local purposes, it should be iced. For any particularly long operation the limb may be kept on a bed of ice bags. Contrary to usual custom, the cooler the atmosphere of the operating room the better; and there is even the possibility that for operations lasting one to several hours the windows might be opened in winter or artificial cooling provided in summer.<sup>1</sup>

When all is in readiness for closure of the wound, the tourniquet is released. Circulation returns promptly, in a degree proportioned to the existing arterial supply, and bleeding points, usually eight or ten in number, can be caught and ligated. The anesthesia then continues at least long enough for convenient completion of suturing.

Our experience has corroborated Allen's findings as regards the condition of the tissues seen in stumps of legs amputated under refrigeration anesthesia. The skin is blanched but fresh. The muscles are bright red and have a fresh appearance. The blood vessels are wide open, and when the tourniquet is removed fresh red blood flows freely from them, indicating the absence of all thrombosis. As stated by Allen:<sup>2</sup> "The tissues have the appearance of a leg of beef which has hung in a refrigerator for days."

#### DRAINAGE

The technic employing silk or cotton without drainage is the ordinary rule, but anything from small drains to a wide-open wound may be adopted, according to the degree of infection. Unfavorable tissue reaction to drains is prevented by cold. The character of the discharge, also, is noteworthy. Even if it is dark, thick or putrid at the outset, it soon changes to a profuse, thin, serous liquid, colored bright pink with hemoglobin. Cold prevents sealing of the wound edges and pocketing of exudate. Closely apposed flaps thus

may remain ununited and irrigated from within as long as chilling is continued. Whenever it is desired to stop the drainage, elevation of the temperature results in rapid agglutination of the margins of the wound.<sup>2</sup>

#### NECROSIS

The theory of this point is that nothing can be done to increase greatly the supply of blood, but reduced temperature can greatly reduce the need of the tissues for oxygen and food. Fears of a corresponding contraction of arteries reducing the blood flow have not been substantiated. Also, a reason should be found for the familiar gangrene or failure of healing in amputations below the knee, even when the unwounded calf tissues appear to be in no danger of gangrene. This reason may be found, theoretically, in postoperative inflammation, with a demand for hyperemia which cannot be met by vessels barely adequate for ordinary nutrition.<sup>2</sup> Both the exaggerated inflammatory need and the ordinary resting need of the tissues for blood have been reduced by cold.<sup>1,2,4,8</sup> Therefore, necrosis may be prevented and sound healing obtained; if the circulation is inadequate, necrosis is limited and slow, and re-amputations are easily performed without deaths. There is thus greater freedom in selecting low levels of amputation if desired for either local or systemic reasons.<sup>2</sup>

#### THROMBOSIS

Spreading thrombosis, sometimes extending rapidly up a limb and entailing a correspondingly rapid gangrene, has been found to be due to damage of the vessel walls, arising from bacterial action in infectious cases, from lack of nutrition and oxygenation in pure arteriosclerotic cases, or often from combinations of these two cases.<sup>1</sup> Cold acts directly to retard clotting as evidenced by the absence of coagulation in the ligated refrigerated limbs of animals.<sup>13</sup> It is presumably due not so much to an inhibition of the clotting

process as to a preservation of the vessel walls by cold. As bacterial activity is also prevented or retarded the danger of thrombosis should theoretically be avoided or minimized. This expectation seems to be fulfilled by the absence of any sign of this danger in the reported experiences thus far. This principle may, therefore, prove useful, in addition to heparin, for the treatment of other conditions in any accessible part of the body.<sup>1</sup>

Several patients with deep venous thrombosis of the lower extremities, all candidates for ligation and division of the femoral vein, according to the usual requirements for such a procedure, have been treated by local chilling of the tissues, as reported by O'Neill.<sup>3</sup> All improved without further treatment. This observation is not particularly convincing, since many such patients improve with rest alone. It may be of value, however, in suggesting that prolonged cold, without freezing, inhibits thrombosis. O'Neill stated, however, that his preference in the treatment of deep venous thrombosis, is still in interruption of a proper deep venous channels.

#### AFTER-CARE

The guiding principle of postoperative management has been to reduce the temperature to whatever extent may be necessary but to raise it as fast and as far as may be safe. Following operation, it has been recommended that refrigeration of the stump may be maintained by means of ice bags against a thin dressing, gradually reducing the refrigeration over a period of several days. In patients with an adequate blood supply, there is no objection to letting the stump return immediately to normal body temperature. The abundant proof of normal healing in animals by this method has been duplicated in the small human experience including both thigh and calf. But by means of temperature regulation a whole series of important new controls have become

available when needed, as noted by Allen.<sup>1</sup>

"1. When there has been threatening signs of loss of vitality in wound flaps or mutilated tissues, the surgeon heretofore has stood helplessly by and watched slough. The sloughing is obviously due to a deficient nutrition, especially oxygen. There is no means for an immediate and effective increase of blood supply, but it is immediately possible to reduce the tissue metabolism to a level for which the existing blood supply is adequate. When necessary the temperature can be lowered to a point at which tissues can survive for a considerable time without any circulation. Some experiences indicate that such control can actually be maintained during the critical period until the circulation improves.

"2. If operation, shockless in itself, has left damaged tissues which may set up postoperative shock, especially in a weak patient, this danger period can be bridged by temperature control. Shock production by tissues is inhibited in proportion as their temperature is reduced. The temperature may be raised gradually accordingly as the local tissue vitality and the constitutional state may permit."

"3. A fundamental problem of surgery is created by the tendency of wound edges to agglutinate and thus seal up collections of fluid which are liable to become decomposed or infected. With refrigeration just as with other forms of anesthesia, it has proved possible to close wounds completely without drainage under favorable conditions, as in the thigh.<sup>1,2,3,4,10</sup> But diabetic or arteriosclerotic limbs commonly present special difficulties, because of the dangers of pressure from close coaptation of the edges, while drains have recognized disadvantages including the irritant action of the foreign body. It is known from animal experiments that the most active of all agglutinating processes, namely, that the peritoneal surfaces and especially of the omentum, is completely inhibited by cold. Human operations have added the information that agglutina-

tion and drainage in wounds can be similarly controlled. For an undetermined length of time, certainly for a number of days, the wound margins can be kept healthy and in close approximation, yet not sealed. Discharge may continue abundantly; and even if it is dark at first because of the state of the tissue, it rapidly changes under cold. It cannot decompose or become infected because enzymes and bacteria are checked by the low temperature. By raising the temperature at any time the wound margins can be made to agglutinate within a few hours and the exudate assumes the usual character or ceases."

Two definite errors have been responsible for any slight blistering or necrosis that has been encountered thus far. One was reduction of temperature to the point of actual freezing. The other was pressure. It is necessary to bear in mind that pressure injures tissues, especially if they are bloodless and at abnormal temperature; and while there is remarkably good tolerance of the severe pressure of a tourniquet for a considerable time, perhaps because of a protective influence of thorough chilling, there is a possibility of ulceration from the minor pressure of ice bags or bandages. Although these dangers are readily avoidable and have not proved serious, they must be borne in mind.<sup>8</sup>

Crossman, Ruggiero, Hurley and Allen,<sup>7,8</sup> analyzed their results in 101 amputations with refrigeration anesthesia. The mortality rate in this series was 15 per cent. McKittrick<sup>6</sup> stated that the mortality rate in amputation for diabetic gangrene ranges from 13 to 80 per cent. Considering only the diabetic cases in the Crossman series, ten deaths out of forty-seven patients with an average age of sixty-five years, the mortality rate rises to 21 per cent. Glassner<sup>22</sup> reported an over-all mortality rate of 38.8 per cent. Of these only two were due to operative interference which leaves a mortality rate of 11.1 per cent.

In our small series of twelve cases there were two deaths; the first was due to a pulmonary embolism on the seventh postoperative day, and the other was due to a streptococcic septicemia, the patient living sixteen days after operation. This

Pain is relieved in most instances after the application of cold, thus adding to the ease and comfort of the patient as well as facilitating preoperative preparation. The postoperative period is likewise free from pain, and the patient may carry

TABLE I

| Hospital Number | Date of Operation | Age | Sex | Race | General Diagnosis                            | Local Condition                           | Patient's Condition | Operation                                  | Comments   |
|-----------------|-------------------|-----|-----|------|--|---|---------------------|--|--|
| 16701           | 4/22/44           | 78  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene left foot infection              | Very poor           | Left supracondylar amputation              | Stump incompletely healed at discharge                 |
| 50651           | 5/8/44            | 75  | M   | W    | Arteriosclerosis diabetes mellitus           | Gangrene left foot                        | Fair                | Left supracondylar amputation              | Healed per primum                                      |
| 92220           | 11/18/43          | 78  | F   | W    | Arteriosclerosis peripheral vascular disease | Gangrene embolism femoral artery          | Poor                | Left supracondylar amputation              | Died 7 days, post-operative pulmonary embolism         |
| 22259           | 3/16/44           | 79  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene right foot                       | Poor                | Right supracondylar amputation             | Healed per primum                                      |
| 22259           | 2/4/43            | 79  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene left foot                        | Poor                | Left supracondylar amputation              | Healed per primum                                      |
| 89377           | 10/5/42           | 56  | M   | W    | Arteriosclerosis vascular disease            | Gangrene left foot lymphangitis           | Poor                | Left supracondylar amputation              | Lymphangitis and cellulitis stump skin grafting        |
| 89424           | 10/5/42           | 59  | M   | W    | Arteriosclerosis                             | Gangrene left foot                        | Fair                | Left supracondylar amputation              | Healed per primum                                      |
| 36338           | 3/15/43           | 58  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene left foot ascending lymphangitis | Very poor           | Left supracondylar amputation              | Died 16 days post-operatively streptococcic septicemia |
| 25840           | 6/28/44           | 54  | M   | W    | Bronchial asthma peripheral vascular disease | Gangrene right foot                       | Poor                | Right supracondylar amputation             | Slough of stump  |
| 25840           | 7/7/44            | 54  | M   | W    | Bronchial asthma peripheral vascular disease | Slough stump                              | Poor                | Amputation lower $\frac{1}{2}$ right femur | Healed per primum                                      |
| 29496           | 7/19/43           | 67  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene right foot                       | Poor                | Right supracondylar amputation             | Healed per primum                                      |
| 29496           | 9/3/44            | 68  | F   | W    | Arteriosclerosis diabetes mellitus           | Gangrene left foot                        | Poor                | Left supracondylar amputation              | Healed per primum                                      |

leaves an over-all mortality rate of 16.6 per cent. All of our patients had supracondylar amputations, performed according to a modification of the Callander technic. (Table I.)

#### SUMMARY

The use of refrigeration anesthesia for major amputations of the limbs is a sound surgical procedure. It is applicable in particular to the poor risk patient since there is scarcely any shock accompanying the procedure. It is possible to perform major amputations safely with this form of anesthesia in what formerly were hopeless cases because of debility or septicemia. It lowers the incidence of stump infections in those patients requiring amputation because of infection.

on without missing a meal. This is especially important in diabetics as the diet and insulin do not have to be changed.

There is ease and quickness of operation in these cases. Poorly nourished tissues may be saved although refrigeration will not restore devitalized tissue. Edema and drainage may be controlled postoperatively when necessary. There is also a reduction in the incidence of thrombosis and embolism.

This method of anesthesia is also valuable in severe crushing wounds of the extremities or other injuries that require amputation.

This form of refrigeration is not intended to supersede other forms of anesthesia when the general condition of the patient is good, but is a valuable adjunct in the treatment of the poor risk patient.

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IN a severely shocked patient whose blood pressure is already low, a further fall may lead to a cerebral anaemia of such degree as to depress the vital centres beyond the limits compatible with life. Therefore, it is absolutely contraindicated to administer a spinal anesthetic to a wounded patient who is suffering from shock.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (Williams & Wilkins Company).

# HYPOPROTEINEMIA IN SURGERY OF THE THORAX

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EVALUATION of protein levels in chest surgery has not received as much analytical attention as in the field of abdominal operations. With the increasing value and realization that a low blood protein level is not only of metabolic interest but also a factor of operative morbidity and even mortality, much such investigation into protein shift, levels, and dynamic chemistry has been studied in the past three or four years.

The concepts of Donnan equilibrium, Starling's Law of oncotic pressure, and even the rôle of the liver as an active factor in protein dynamics have been altered not only in theory but also in its relations to therapy.

Recent work suggests that protein molecules will even diffuse through cellular membranes maintaining a balance between intrinsic cellular metabolism and the cellular fluids bathing them. The clinical application of this experimental fact has far and wide reaching implications.

The value of protein maintenance in normal wound healing with its attendant fibrinogen necessity, and even the non-specific globulin and albumin aids to immunological response and local tissue healing has been rather voluminously reported. Clinically, a total protein value of below 5 Gm. per cent will find healing markedly impeded; and as one goes down the scale gaping of fascial planes, herniation, and finally evisceration are the inevitable aftermaths.

The attendant cardiorenal dysfunction below a total protein value of 5 Gm. per cent and an albumin value of below 3.2 Gm. per cent will yield a final anasarca. Even a patient who is a good surgical risk

undergoing an emergency appendectomy with attendant little trauma will still demonstrate postoperatively a fall of protein varying from 1 to even  $1\frac{1}{2}$  Gm. in the first forty-eight hours. All things being equal, he will resume his normal protein balance in about ten days. However, even here, the incalculable but ever present loss of protein from operative trauma, minimal though it may be, to a serous membrane (the peritoneum) is evidenced by the oft-repeated above findings. The more severe the operation the more the postoperative drop, though most operative procedures without excessive loss of blood, postoperative fistulas, or drainage of the peritoneal cavity will usually stay above the critical protein levels before mentioned. It is well to remark that in all cases that because of the small molecular weight and its twofold greater abundance the albumin is always the first fraction that is observed lost, and also the figure that has finally gone the lowest. The globulin factor itself, increasing as it does with infections, will usually make its evaluation in protein shift and levels difficult in the integration of this protein imbalance.

Realizing the import of all factors in their inestimable and imponderable value in safely guiding a patient through his hospital stay with a difficult operation and intricate postoperative care, protein metabolism and its implication to thoracic surgery have been studied.

Surgery of the thorax differs in many respects from general, and specifically, abdominal surgery. Though it be true that technical skill, anatomical familiarity and clinical judgment must be tempered by diagnostic conundrums in both cases, yet



there is a distinct schism between the two fields.

A laparotomy entails no problem of disturbed physiology of vital organs and the unpredictable effects on different individuals with the same procedures. Mediastinal shift with its attendant effect on the cardiorespiratory mechanism, the exposure of extremely large serous surfaces to air trauma, and increased (atmospheric) pressure, the prolonged nature and time of operation of all intrathoracic operations, the interference continually with vital tissues in their normal balance and conductivity of fluid flow and impulse transmission, the necessity for positive pressure anesthesia with its coincidental effect on medullary centers and cerebral anoxemia, the repeated chronicity of most thoracic operations which are serial investigations and the attendant poor morale and physical condition of the patient—all these make every factor, even though minute, of infinite import in chest surgery.

Attempting to anticipate blood loss by transfusion preoperatively and on the table, using wet hot towels, skin protection to reduce surface fluid loss and minimize infection, plus anesthesia by intratracheal insufflation to control respiratory quotient and balance are means adopted to overcome a necessary nitrogen imbalance. Exactly what demands are made on protein reserve in the liver, body tissues, and circulating blood volume by fluid shift, terrific metabolic needs with attendant breakdowns of non-storage, vital organ needs in thoracic surgery is hard, or at times impossible to calculate, and even arbitrarily to anticipate. Particularly is this true when one realizes that all of these illnesses being chronic, there is necessarily some degree of amyloidosis and fatty degeneration of the liver and other potential storage depots. Such livers and tissues thus store and metabolize less protein even when an abundance is given them at some future date. Liver function tests with the Congo red, hippuric acid, prothrombin, cephalin or blood protein

levels are only relatively accurate when one realizes the immense reserve of such organs.

Rapid replacement of protein is, however, still all too frequently an emergency. It is difficult for one to realize that a thoracotomy tube draining an average acute empyema or postoperative pleural effusion will remove a sizeable amount of protein from the blood in twenty-four hours. The average amount of protein will vary from a minimum 3.6 per cent to a maximum of 7 per cent. The quantity of fluid varies from 350 cc. to as much as 4,000 cc. daily in postoperative effusions depending upon the type of operation, degree of atelectasis, previous protein imbalance, fluid loss and replacement during operation and complications postoperatively which ensue. This loss of pleural fluid and the outpourings of all serous surfaces is probably one of the largest factors in the rôle of hypoproteinemia in chest cases. Particularly, one must realize that ascitic fluid will vary from 1 to 3 per cent depending upon the length, type, and extent of hepatic cirrhosis, whereas all pleural effusions vary from twice to three times this amount continually. A patient postoperatively, who has a pleural effusion of 2,500 cc. drained off or even left in the chest cavity has a loss of almost half of the circulating blood protein. Replacement by exogenous sources must, therefore, be incessant since endogenously it can be supplied only as an emergency or replacement therapy.

Checking the urinary albumin we know that for every Gm. of albumin in the urine, 30 Gm. of body proteins must be broken down. Thus the blood protein value is of sheer necessity the difference all too frequently between autonomic cannibalism and bodily survival. In extreme cases this progressive depletion of circulating blood protein due to the continual loss of protein from weeping, inflammatory and secreting surfaces continues. Then the liver falls into a vicious cycle of adding to its already overtaxed vital reserve the necessity of increased formation of albumin and globu-

lin. The source of added protein increment now comes from endogenous breakdown and frenzied, forced exogenous intake. The inevitable happens as witnessed in Cases I and XIII. The progressive downhill courses of these patients are paralleled by their increasing hypoproteinemias. Once these inflammatory processes in the pleural cavity are well under way and protein imbalance obtains, restoration of normal values are most difficult to restore and maintain despite intravenous amino acids, plasma and high protein diets.

The balance of protein is obtained roughly through the interplay of four factors: (1) The exogenous source (food); (2) the synthesis of albumin, globulin and fibrinogen by the liver after protein breakdown and amino acid splitting; (3) loss of protein through increased metabolism and pathological continued inflammation (effusion and empyema), and (4) the excretion, mainly urinary albumin.

In thoracic surgery all of the above factors are vitiated. Even before operation and sometimes the immediate decisive factor for rapid recourse to operation are the peculiar pathological processes in the thorax along with its minion, hypoproteinemia. For if the patient has a cancer of the esophagus the food intake is diminished, the liver is affected as part of a malignant toxic depression, and so protein imbalance effected. The kidney's excretion is now impaired since liver formation of urea is diminished, and with diminished protein a lowering of the oncotic pressure in the blood obtains. Fluid resorption in the tubules now is faulty. Finally, with this progressive damage to the kidney, loss of albumin occurs. Here, we have a progression of events involving merely a conducting tube (esophagus), but with a thoracic location. Operation of a patient with this condition adds the problem of opening a thorax with further loss of pleural surface, blood loss and all the superimposed factors, which further push the patient down the road toward an increasing hypoproteinemia.

The chronic cases with draining pleural surfaces offer a divergent problem. Here one can assume that a thoracotomy tube will drain an overall average of from 1,000 cc. per twenty-four hours, for the first three or four days after its introduction into the offending thoracic fluid accumulation.

With a minimum protein of about 4 per cent the patient is losing per day a protein content equivalent to between 500 to 600 cc. of circulating blood volume per day, or roughly 10 to 12 per cent of his total plasma protein. Normal protein values of  $7\frac{1}{2}$  Gm. per cent obtaining, it could take some sixty hours to reach a critical level of 5 Gm. per cent were it not for replacement by liver and tissue cell protein reserves.

However, these endogenous sources supply only a small, and at that, a transient replacement. With the obvious poor gastrointestinal digestion and assimilation of such debilitated or postoperative patients, but little exogenously of protein content will help this increasing negative nitrogen balance.

The use of blood transfusions, plasma, amino acids by mouth or parenterally, must be employed to augment protein intake. By far the most expedient and economical protein replenishment is intravenous or intramedullary use of amino acids. Amino acids for usage are divided into two classes, both being digests of 10 per cent casein. One is an acid hydrolysis with the addition of tryptophane to the final product and the other is an enzymic digest; the latter needs no addition of tryptophane but offers the disadvantage of possible side and allergic reactions through the presence of peptones and polypeptides.

The amino acid therapy consists of 60 to 90 Gm. daily given through the intravenous route. If the enzymic preparation is given, the sugar concentration in the diluting fluid must be higher than any hydrolytic preparation of amino acids. As a general rule a 10 to 15 per cent coverage of glucose in saline in resultant

TABLE I\*

| Operation                                    | Preoperative | Postoperative |           |
|--|--------------|---------------|-----------|
|  |              | Immediately   | Following |
| Case I (W. H.)                               |              |               |           |
| Lobectomy                                    |              |               |           |
| Total protein...                             | 7.95         | 5.92          | 4.30      |
| Albumin...                                   | 6.00         | 4.40          | 2.20      |
| Globulin...                                  | 1.95         | 1.52          | 2.10      |
| Ratio...                                     | 3.07         | 2.90          | 1.05      |
| Case II (R. Z.)                              |              |               |           |
| Thoracoplasty                                |              |               |           |
| Total protein...                             | 7.50         | 6.60          | 6.00      |
| Albumin...                                   | 5.50         | 4.20          | 3.00      |
| Globulin...                                  | 2.00         | 2.40          | 2.20      |
| Ratio...                                     | 2.75         | 1.75          | 1.73      |
| Case III (J. G.)                             |              |               |           |
| Esophagogastrostomy<br>(Megaeosophagus)      |              |               |           |
| Total protein...                             | 8.50         | 6.25          | 8.00      |
| Albumin...                                   | 6.00         | 4.25          | 5.00      |
| Globulin...                                  | 2.50         | 2.00          | 3.00      |
| Ratio...                                     | 2.39         | 2.13          | 1.67      |
| Case IV (L. L.)                              |              |               |           |
| Plastic Revision of chest<br>(Thoracoplasty) |              |               |           |
| Total protein...                             | 7.00         | 6.15          | 7.20      |
| Albumin...                                   | 4.50         | 3.50          | 3.90      |
| Globulin...                                  | 2.50         | 2.65          | 3.30      |
| Ratio...                                     | 1.80         | 1.52          | 1.18      |
| Case V (L. McK)                              |              |               |           |
| Thoracoplasty                                |              |               |           |
| Total protein...                             | 6.25         | 4.00          | 7.00      |
| Albumin...                                   | 5.00         | 3.00          | 5.00      |
| Globulin...                                  | 1.25         | 1.00          | 2.00      |
| Ratio...                                     | 4.00         | 3.00          | 2.00      |
| Case VI (L. J.)                              |              |               |           |
| Ant. Thoracoplasty                           |              |               |           |
| Total protein...                             | 8.50         | 6.50          | 5.75      |
| Albumin...                                   | 3.60         | 3.00          | 3.50      |
| Globulin...                                  | 4.90         | 3.50          | 2.25      |
| Ratio...                                     | 0.76         | 0.80          | 1.50      |
| Case VII (S. C.)                             |              |               |           |
| Thoracoplasty                                |              |               |           |
| Total protein...                             | 7.00         | 5.50          | 7.00      |
| Albumin...                                   | 5.00         | 3.50          | 5.00      |
| Globulin...                                  | 2.00         | 2.00          | 2.00      |
| Ratio...                                     | 2.50         | 1.75          | 2.50      |
| Case VIII (E. McG)                           |              |               |           |
| Thoracoplasty                                |              |               |           |
| Total protein...                             | 6.50         | 5.50          | 7.20      |
| Albumin...                                   | 4.00         | 4.50          | 4.20      |
| Globulin...                                  | 2.50         | 2.00          | 3.50      |
| Ratio...                                     | 1.60         | 2.15          | 1.40      |
| Case IX (M. K.)                              |              |               |           |
| Thoracoplasty                                |              |               |           |
| Total protein...                             | 5.00         | 4.50          | 5.50      |
| Albumin...                                   | 2.50         | 2.50          | 3.50      |
| Globulin...                                  | 2.50         | 2.00          | 2.00      |
| Ratio...                                     | 1.00         | 1.25          | 1.75      |

TABLE I\* (Continued)

| Operation   | Preoperative | Postoperative |           |
|---|--------------|---------------|-----------|
|   |              | Immediately   | Following |
| <i>Case X (M. V.)</i>                             |              |               |           |
| Thoracoplasty                                     |              |               |           |
| Total protein.....                                | 7.60         | 6.50          | 6.20      |
| Albumin.....                                      | 5.50         | 4.80          | 4.20      |
| Globulin.....                                     | 2.10         | 1.70          | 2.00      |
| Ratio.....  | 2.62         | 2.82          | 2.10      |
| <i>Case IX (W. S.)</i>                            |              |               |           |
| Thoracoplasty                                     |              |               |           |
| Total protein.....                                | 7.00         | 6.50          | 5.50      |
| Albumin.....                                      | 5.00         | 4.50          | 2.50      |
| Globulin.....                                     | 2.00         | 2.00          | 3.00      |
| Ratio.....  | 2.50         | 2.25          | 0.83      |
| <i>Case XII (J. G.)</i>                           |              |               |           |
| Plastic revision of chest wall with rib resection |              |               |           |
| Total protein.....                                | 6.80         | 6.00          | 7.20      |
| Albumin.....                                      | 4.00         | 4.00          | 4.50      |
| Globulin.....                                     | 2.80         | 2.00          | 2.70      |
| Ratio.....  | 1.43         | 2.00          | 1.69      |
| <i>Case XIII (H. S.)</i>                          |              |               |           |
| Closed thoracotomy                                |              |               |           |
| Total protein.....                                | 5.52         | 4.40          | 3.00      |
| Albumin.....                                      | 2.40         | 1.90          | 1.00      |
| Globulin.....                                     | 3.12         | 2.50          | 2.00      |
| Ratio.....  | 0.77         | 0.76          | 0.50      |
| <i>Case XIV (C. R.)</i>                           |              |               |           |
| Open Thoracotomy                                  |              |               |           |
| Total protein.....                                | 7.75         | 6.50          | 8.00      |
| Albumin.....                                      | 6.00         | 4.00          | 5.00      |
| Globulin.....                                     | 1.50         | 2.50          | 3.00      |
| Ratio.....  | 4.00         | 1.60          | 1.67      |
| <i>Case XV (S. R.)</i>                            |              |               |           |
| Cavernostomy                                      |              |               |           |
| Total protein.....                                | 7.20         | 5.80          | 5.80      |
| Albumin.....                                      | 4.30         | 3.50          | 2.50      |
| Globulin.....                                     | 2.90         | 2.50          | 3.30      |
| Ratio.....  | 1.48         | 1.75          | 0.76      |

\* An analysis of the protein figures in the above table demonstrate several pertinent and definitive conclusions: (1) All protein values drop postoperatively. (2) Their return to normal or the normal level for that patient who has had a diminution in vital capacity and other organ reserve depends upon two things: (a) the degree of damage to vital organs the patient has already had due to his offending pathological condition or previous operative insults; (b) the type and severity of operation instituted. (3) Serial operations such as thoracoplasties of a three-stage nature place a much greater drain upon metabolism of the body, especially protein, than is probably recognized since it will be noted that in such cases such as No. II, VI, V, VIII, X, a return to a preoperative protein balance does not obtain. (4) Where patients have a loss of fluids and protein through draining thoracotomies or sinuses, loss

solution after the dilution with the amino acid preparation of an enzymic nature must be observed. With the hydrolytic preparations of amino acids, a 5 per cent glucose in saline or less may be used with impunity without untoward actions. In both slow drop of 40 per minute must be observed. By this amino acid administration the average postoperative protein drop will be slowed and eventually return to protein balance of a positive nature. The evaluation of a positive protein balance may be done by juggling the blood protein levels daily against the twenty-four hour urinespecimen's total protein content. The latter calculated as protein per unit specimen times the total amount of urine will give the daily protein loss in the body. Its replacement is completely necessary to keep total protein levels above the critical level of five, and an albumin level of three. In addition, some  $1\frac{1}{2}$  Gm. per kilogram of body weight of protein orally, the liberal use of vitamin B and C must also be given for intestinal assimilation and balanced with vital organ function. A high caloric intake with a moderate fat composition must also be administered.

Evidence of critical protein levels and patients with post-pneumococcic empyemas transferred from medicine was one of the convincing factors in the justification and the investigation of protein metabolism in thoracic surgery. Here the patient's loss of protein into his own thorax was not recognized; and his subsequent downward course not halted, and accordingly not properly treated. The entire fatal problem in these cases was blamed on the illness itself and the subsequent attendant debility of poor oral ingestion of food intake. Postoperatively

anasarca of our patients was also observed until a régime of calibrated protein replacement was established.

We are attempting in this article to demonstrate by an unpicked series of cases the defects in early recognition and treatment of protein imbalance. At this hospital all of our cases comprise the poor risks; the effects of mismanagement at other places of medical care, the patients who have had many and crippling operations, the indigent who have been unable to secure proper care and sustenance between periods of medical attention, the gyriatric with their catabolic complications, and the far advanced pulmonary tubercular patient. In our series we have patients admitted with one kidney, bilateral tuberculosis, megalo-esophagus complicated with tuberculosis, thoracoplasties with thoracotomy drainage of empyema cavities, thoracoplasty complicated with carcinoma on the opposite side, and tuberculosis with peptic ulcer.

The thoracic surgical patients represent more possibly the single largest major group of chronically ill patients who may somehow be helped surgically. Concomitantly, the very nature of their illness represents one of the largest groups who can be helped most by attention to this insidious and incessant breakdown of body and tissue protein occurring through the prolonged severe nature of their illness and the corrective operations.

This group of patients may be lumped into a classification of the pneumococcic tuberculosis designation with the complications of these two pathological processes. It is to be reiterated that with this type of prolonged illness the patient will exhibit not only a faulty ingestion due to continual anorexia, but also poor assimilation of protein through constant debilitation. The vicious cycle thus obtains of a body injured by depletion of protein being unable to take care of the protein it so seriously needs. And then the addition of traumatic insults through operation is added. The following cases represent the series done

of fluid into the pleural cavity such as empyemas or pleural effusions preoperative protein normalcy takes an indefinite period of time to assume normality. Witness cases No. II, III, VI, IX, XII, and XIII. (5) Prognostication as to the ultimate fate of the patient may be correlated with rapid protein imbalance. When total protein falls below five and the albumin falls below three with a relative increase in globulin, reversing the A/G ratio, that patient's ability to survive ceases as in the cases I and XIII.

from January, 1944, to date. They run through the gamut of the minor surgical operation of a closed thoracotomy for

underwent a lobectomy expired due to complication of tremendous postoperative pleural effusion which depleted her protein

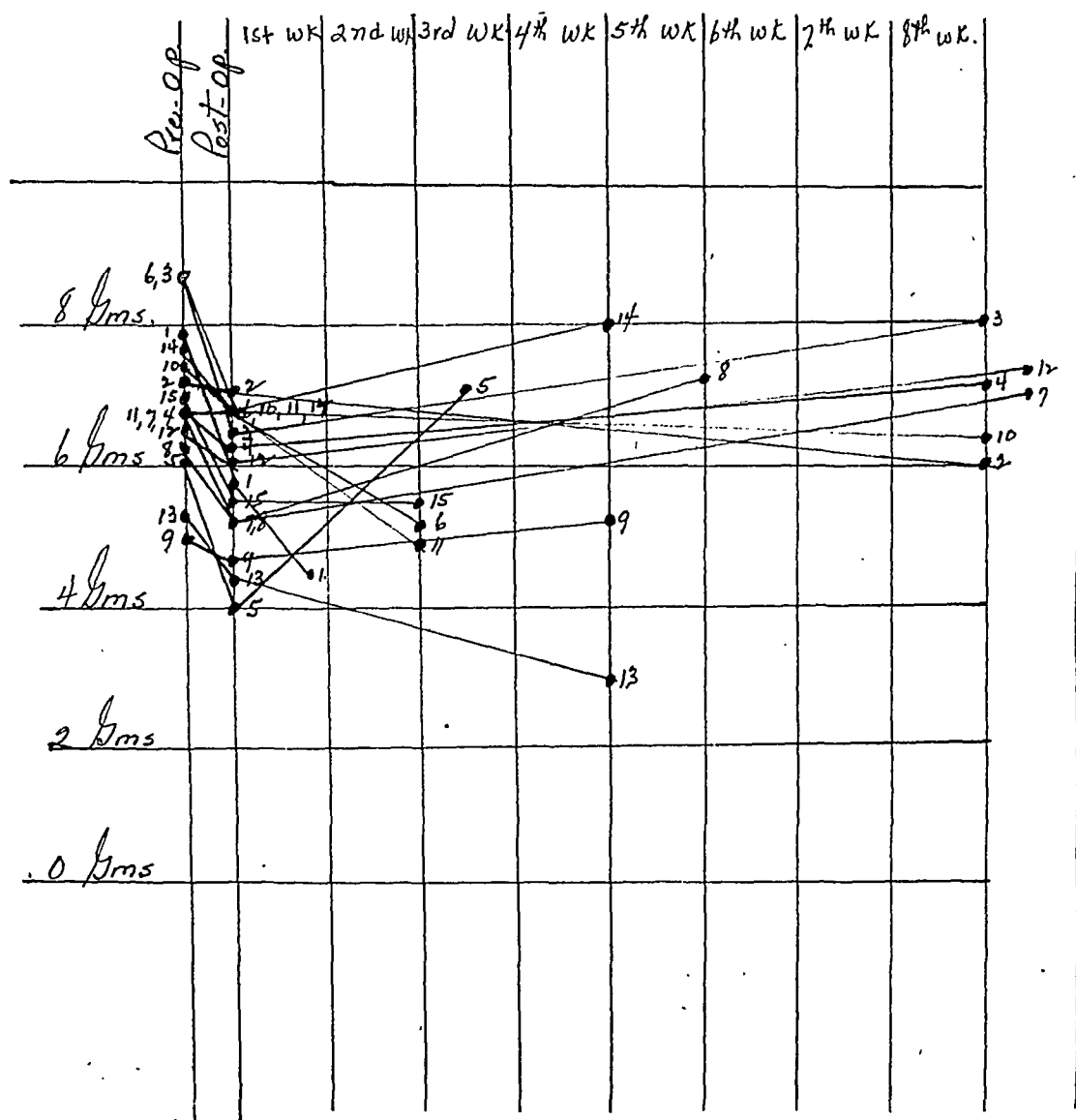


FIG. 1. Fifteen cases are charted for preoperative and postoperative total blood protein levels.: (1) All but four cases returned to normal preoperative values by two months. (2) Two cases which fell below the preoperative values after operation and continued downward expired. (Critical values of albumens below 2.50, total proteins below 4.50 obtained.) (3) Two cases did not return completely to preoperative levels because of intervening operative procedures. (4) One case with bilateral advanced tuberculosis after cavernostomy still below normal. (Two weeks postoperatively—time of writing of paper.)

empyema to the extensive operations of lobectomy and esophageal gastrostomy for megalo-esophagus. The two patients who expired in this series represent extreme instances of variation in the magnitude of surgical technic. The first patient who

reserve below a critical level despite massive continual blood transfusion replacement. Case XIII represents the result of inadequate treatment of a pneumococcal empyema with the lack of recognition of a protein loss which the patient was losing

into his own chest cavity. The cases to be presented follow:

#### CASE REPORTS

**CASE I.** A thirty-nine year old white female had post-pneumonic right upper lobe lung abscess. Pneumonostomy drainages had been done. Following this, recovery obtained with the removal of tubes, closure of the external wound and clinical and symptomatic improvement. The patient returned with a story of chills in the back, hemoptysis, bouts of dyspnea, and fatigue.

Physical examination revealed a well nourished, robust, ambulatory, non-febrile nondyspneic female. The trachea was in the midline. There was no cervical adenopathy. The apex beat was at the fifth interspace, mid-clavicular line, and there were no murmurs. A small cicatrix at the third interspace anteriorly on the right side was completely healed. Breath sounds and percussion note throughout both sides were essentially within normal limits. The extremities showed no clubbing, cyanosis or edema.

Impression: A residual healed lung abscess cavity (lung cyst) of the right upper lobe.

By means of standard x-rays of the chest, tomographic studies and bronchography, two cavities occupying the lower half of the right upper lobe and located about 14 cm. from the posterior chest wall were observed.

The patient was operated in February for right upper lobectomy. A large epithelialized lung cyst communicating with a patent bronchus in the right upper lobe was found and removed *in toto* as part of the lobectomy. The patient developed a profuse pleural effusion which drained through the thoracotomy tube inserted at the time of operation in the sixth interspace. A secondary bronchopneumonic process of the lower part of the left upper lobe obtained and on the fourth day the patient expired.

Postmortem findings showed an atelectasis of the right middle lobe, a partial atelectasis and bronchopneumonic process of the right lower lobe and a bronchopneumonic process of the lower part of the left upper lobe.

**CASE II.** R. Z. was admitted to the Tuberculosis Pavilion on February 3, 1944, and was admitted to the Thoracic Surgery service on February 8, 1944. He was a thirty year old white male with a history of tuberculosis, left

side, with cavitation since 1936. The patient then had pneumothorax at Bellevue, and had in succession Jacobean, and phrenic nerve crush, spontaneous pneumothorax, and then effusion and empyema with a thoracotomy. He had three stages of thoracoplasty starting in 1938 to date. He was discharged and then returned with a sinus tract. He again had empyema which had another thoracotomy done. He had had three stages of plastic revision for chronic empyema.

Physical examination revealed a bedridden patient, markedly anemic, toxic, with moderate dyspnea and febrile. The heart showed a slight systolic murmur. The apex beat was displaced to the right side about 2 cm. in the sixth interspace. There was normal resonance on the right side with breath sounds increased in pitch and intensity. There was swelling of the left side of the chest wall from about the ninth interspace in the mid-axillary line and running downward and posteriorly just above the iliac crest. There was flatness over this area and the lung fields on the entire left chest except for the clavicular region with no breath sounds. The extremities showed slight clubbing of the fingers, but no unusual cyanosis or edema.

Impression: Tuberculosis of the left lung with chronic empyema, probably postdating the original pneumothorax treatment and not obliterated after the thoracoplasty procedures.

A small incision was made over the ninth interspace, mid-axillary line, and a tube inserted into and through the chest wall into the empyema cavity. A gush of 200 to 300 cc. of yellowish-brown turbid fluid without odor obtained. The tube was connected with underwater drainage. Further operations were then done to unroof and obliterate the empyema cavity. The first stage revision thoracoplasty was performed in March 2, 1944, the second on April 6, 1944, and the third stage revision thoracoplasty on May 11, 1944.

**CASE III.** J. G. was admitted March 8, 1944 and discharged May 15, 1944. The total hospital stay was sixty-eight days, the post-operative stay fifty-six days. The patient was a twenty-nine year old colored male with a history of left pulmonary tuberculosis. Sputum was always negative, even at Otisville during a three-months' stay. The patient had trouble swallowing and stomach trouble. Diagnosis: Ulcers for about one and a half years. He had regurgitation after each meal which be-

came progressively worse. There was no cough or hemoptysis. This condition was discovered in a routine chest examination one week after admission to Otisville.

Physical examination revealed an attenuated colored male, 5 feet 11 inches tall. The heart revealed no murmurs; it was regular in outline and size. The apex beat was at the sixth interspace. There was some dullness in the left apex of the lungs but no râles or change in breath sounds. The abdomen was scaphoid in shape. The extremities were not clubbed or cyanotic.

Impression: (1) Achalasia esophagus; (2) cardiospasm; (3) tuberculosis? left apex.

Esophagogastrostomy was done on March 20, 1944. Esophagoscopy with Levine tube passage was performed on March 16, 1944. The operation after esophagoscopy was done with Levine tube passage. At this time the patient was receiving intravenous feedings. He could tolerate nothing by mouth.

The patient was kept on sulfadiazine because of fear of infection of the pleura and mediastinum after opening of the esophagus. The temperature went up postoperatively, going up and down in what appeared to be due to either inadequate drainage or absorption of blood or foreign protein. On the sixth day it went up to 104.8°F. with respirations 34, pulse 120, and the patient looked toxic (March 25, 1944). On March 24th the Levine tube was pulled out by the patient. It was reinserted and x-ray showed correct position. On the following day the tube was removed and his temperature, pulse and respirations went up five hours later. On March 26th a chest tap was done and 50 cc. of serosanguineous fluid, high protein, was obtained. The patient improved with oxygen and supportive care.

The chest findings were always the same. There were no signs of atelectasis, fluid increase, shift in trachea, etc. On March 28, 1944, the patient still had a low grade temperature, but the wound which was infected down to the fascia was considered part of the factor. Tyrothricin was used for irrigating and wet dressings,  $\frac{1}{10}$ th dilution. The Levine tube was removed while the patient swallowed ice and mineral oil.

On April 17th, physical findings suggested fluid in the left base as did x-ray findings (tuberculosis x-rays showed resorption fluid). The patient was fluoroscoped for determination of fluid. A tap was done and 250 cc. of thick, sero-

sanguineous fluid was obtained. On April 20th the temperature, pulse and respirations were normal. There was slight post-prandial pain, some colicky component, but no obstructive signs or symptoms. The patient was ambulatory. Tincture of belladonna and mineral oil, and a gastrointestinal series was ordered. On May 15th, fluoroscopy demonstrated that anastomosis was good, the cap was working well and the patient was discharged.

CASE IV. L. L. was a fifty-three year old male with a history of pneumonia followed by chronic empyema. He then had bloody urination and had the left kidney removed for diagnosis of a tuberculous kidney. The patient had left-sided empyema again which betrayed itself with a septic temperature.

Physical examination revealed a robust, slightly obese white male, slightly dyspneic. The trachea was in the midline. The apex beat of the heart was at the fifth interspace, mid-clavicular line. The cardiac outline and size were normal to percussion and auscultation. There was slightly increased resonance and slightly increased breath sounds with emphysematous tinge. There were dullness and diminished breath sounds on the right side of the pulmonary field anteriorly and posteriorly below the fourth interspace. Above this area there was slightly increased breath sounds with a little more resonance. There was the mark of an incision in the left loin with slight herniation (site of nephrectomy, 1942). No liver, spleen or other masses were palpable, and the extremities showed no clubbing or cyanosis.

Operative procedures designed at obliteration of the chronic empyema cavity by collapse of the chest wall through removal of ribs above were then done. The series of operations were done on January 10, 1944, January 27, 1944, February 26, 1944 and March 27, 1944. The removal of from the third to the eighth ribs inclusive, over the cavity reduced it to a narrow sinus tract which now held about 60 to 80 cc. in contrast to the original 400 to 500 cc. capacity of the original empyema cavity size.

However, the patient developed signs of liver damage with jaundice and a rather severe anemia. Associated with this clinical depression the patient's morale became too poor to have further operative procedures at this time. He was, therefore, sent home to convalesce and to return when improved. A thoracotomy tube

was left in place in the sinus tract and irrigations desisted because of an air embolism episode just before discharge which fortunately left no sequelae.

CASE V. L. McK. was a forty-six year old white female with a one and a half year history of tuberculosis, right side, with ineffectual pneumothorax treatments. There was no hemoptysis, but positive sputum obtains. Thoracoplasty operations were decided upon for right side lung treatment.

Physical examination revealed a well nourished, slightly obese female, ambulatory, non-dyspneic, non-febrile and not cyanotic. The apex beat was heard at the fifth interspace, mid-clavicular line; there were no murmurs. There were diminished breath sounds below the ninth interspace on the right side and diminished sounds throughout the rest of the lung with slight increase in resonance. The left lung was normal. No liver, spleen or masses were palpable, and the extremities showed no clubbing, cyanosis or edema.

Impression: Tuberculosis, right side, with partial pneumothorax.

X-ray findings showed tuberculosis of right lung with partial re-expansion and with partial pneumothorax.

CASE VI. L. J. was a twenty-five year old colored female with a history of cold and continual cough with temperature in February, 1944. There was no hemoptysis. She was admitted to Harlem Hospital on March 13, 1944, where diagnosis, x-rays and positive sputum of tuberculosis obtained. She was admitted to this hospital, Tuberculosis Pavilion on April 6, 1944, and to Thoracic Surgery service on May 19, 1944, with bilateral tuberculous cavitation of the left lung.

Physical examination revealed a semi-ambulatory patient, slightly dyspneic, not cyanotic and febrile. The trachea was very slightly deviated to the left side but there was no cervical adenopathy. The heart was normal in outline and shape. There were no murmurs and the apex beat was heard at the fifth interspace, mid-clavicular line. On the right side there was a normal percussion not but numerous crackling crepitant râles were heard throughout the chest anteriorly and posteriorly. The left chest had slightly increased resonance with bronchovesicular breathing over the anterior aspect from the first to the fourth interspace. The rest of the chest had slightly impaired resonance

with patches of bronchovesicular alternating with normal breath sounds. Fine crepitant râles were heard throughout the chest. No masses, liver or spleen were palpable, and there were no clubbing, cyanosis or edema of the extremities.

Impression: Bilateral tuberculosis with extensive cavitation on the left side, including a giant cavity in the left apex located anteriorly about 10 cm. in diameter.

The Monaldie operation was done for a giant cavity on the left side, May 25, 1944.

CASE VII. S. C. was a twenty-five year old female with a history of pulmonary tuberculosis of six years' duration. The diagnosis by a private physician was confirmed at Otisville, and then at Bellevue where a thoracoplasty was advised until spread in the right lung presented. The patient came here and after pleno-graphic studies, was advised to have a three-stage thoracoplasty for left apical cavity.

Physical examination revealed a well nourished ambulatory female, afebrile, in good condition without any signs of dyspnea, cyanosis or anemia. The apex beat was heard at the fifth interspace, mid-clavicular line. The cardiac outline was normal in size and shape. On the right side there were essentially normal resonance and breath sounds. On the left side there were dullness and increased breath sounds over the left apex posteriorly with soft crepitant râles over the same area.

Impression: Pulmonary tuberculosis of the left lung with cavitation.

A first stage thoracoplasty was performed on June 1, 1944, followed by an uneventful convalescence.

CASE VIII. E. McG. was a thirty-eight year old white male with a history of tuberculosis of the right upper lung of about one year's duration. The patient had had no night sweats, hemoptysis, or loss of weight. Cough and continual fatigue obtained though, which led to the above diagnosis. In May, 1944, the patient "caught a cold" and tuberculosis spread with cavitation of the right upper lobe and an increasingly positive sputum. Careful consideration of his case argued for immediate institution of thoracoplasty operations for collapse of the right lung rather than institution of pneumothorax treatments. This decision was influenced not only by the extent of the cavitation but also by the presence of



emphysematous blebs which might be ruptured by air installation into the pleural cavity.

Physical examination revealed a well nourished ambulatory, somewhat attenuated male, not dyspneic, febrile, or cyanotic. The trachea was slightly deviated to the right. The apex beat was heard at the fifth interspace; there were no murmurs. In the right upper lobe numerous râles were heard throughout the apex anteriorly and posteriorly. There were occasional patches of bronchovesicular breathing posteriorly. The rest of the lung, and left side were relatively normal. No liver, spleen or masses were palpable, and there were no clubbing, cyanosis or edema of the extremities.

Impression: Tuberculosis of the right lung, especially right upper lobe with cavitation.

X-ray studies showed tuberculosis of the right upper lobe with cavitation in the apex and emphysematous blebs. The left lung was relatively normal.

CASE IX. M. K. was a thirty-seven year old white male with a history of one and a half years' duration of left-sided pulmonary tuberculosis. Initial pneumothorax treatments were followed by pleural effusion and then mixed empyema. Repeated aspiration did not allow for adequate drainage and the patient was admitted for closed thoracotomy. This was done and a first stage thoracoplasty for reduction of the empyema cavity then planned.

Physical examination revealed the patient to be only semi-ambulatory, markedly dyspneic, but with little cyanosis. Low grade febrile temperature persisted. The trachea was deviated to the left. No murmurs were heard and the apex beat was elicited at the sixth interspace, mid-clavicular line. No liver, spleen or masses were palpable, and there were no clubbing, cyanosis or edema of the extremities.

Impression: Right-sided pulmonary tuberculosis with mixed empyema and closed thoracotomy drainage of same.

X-ray studies showed infiltration of the right lung apex with fluid filling the lower two-thirds of the thorax and the tube *in situ* in the sixth interspace. A first stage thoracoplasty on the right side was performed on July 13, 1944.

CASE X. M. V. gave a history of cancer for one year of the left breast with radical mastectomy. Concomitantly the patient was discovered to have tuberculosis of the right apex with cavitation. Pneumothorax treatment and

Jacobaeus operation were attempted ineffectually. The patient was admitted to the Tuberculosis Pavilion early in April and from there transferred to Thoracic Surgery on April 14, 1944, for thoracoplasty operations of the chest.

Physical examination revealed a fifty-four year old white female, robust, with florid complexion, ambulatory, not febrile, dyspneic, cyanotic or edematous. The trachea was in the midline. Shape and outline of the heart were apparently normal. On the right side, dullness posteriorly and bronchial breath sounds in the apical region were heard. There was dullness with diminishing breath sounds in the right base. The left side was normal to percussion and auscultation. A radical mastectomy scar on the left side, site of operation performed in 1943, was visible. On the right upper quadrant, a scar from cholecystectomy (1934) was seen. The liver was palpable one finger down but not tender. No masses or spleen were palpable, and there were no clubbing, cyanosis or edema, of the extremities.

Impression: Tuberculosis of right apex, with probable cavitation and pleural thickening of the right lung.

A three-stage thoracoplasty on right side was done, taking out the first eight ribs. An uneventful recovery followed; sputum was negative and x-ray showed the chest wall collapsed and obliteration of the cavitation in the lung field.

CASE XI. W. S. was a thirty year old colored male with a history of left pulmonary tuberculosis of two years' duration. The patient was admitted for left-sided thoracoplasty. (He gave a history of upset stomach with powders after meals, and kidney trouble on the left side.)

Physical examination revealed a robust colored male, ambulatory, non-febrile. The trachea was in the midline. There were no murmurs and the apex beat was heard at the fifth interspace. There were diminished breath sounds in the left chest posteriorly, mostly in the region of the scapular area and occasional râles and coughing over the apex. The right side was essentially normal. No liver, spleen or masses were palpable. There were no clubbing or cyanosis of the extremities. The right hand was atrophied with partial amputation of fingers due to a bullet wound many years previously.

Impression: Pulmonary tuberculosis on the right side.

X-ray findings confirmed the above impression and demonstrated a good right lung. A first stage thoracoplasty was performed on August 17, 1944.

CASE XII. J. G., a thirty-six year old white male gave a history of pulmonary tuberculosis on the left side of eighteen years' duration. Pneumothorax was initiated and was determined as ineffectual. Continued aspiration of effusion was done until 1935. A bronchopleural fistula was determined at this time by positive x-rays and gentian violet expectoration. A three-stage thoracoplasty in 1937 and 1938 was done. Then a thoracotomy for empyema was performed and the patient sent home with the tube in. In January, 1944, the patient developed a chest wall abscess below the thoracotomy tube. The abscess was incised and drained at that time. He was admitted to chest surgery at the Metropolitan Hospital, on May 22, 1944, with a diagnosis of osteomyelitis of the left chest wall and tuberculosis of the lung.

Physical examination revealed a thin, but well nourished male, ambulatory, and in no acute distress. The trachea was in the midline. The heart was regular in outline and normal in size. There were no murmurs. In the chest wall there was a thoracotomy tube at about the sixth interspace, anterior axillary line, draining yellowish, creamy pus. Another small tube through the sinus tract was superficially located under the skin also in the anterior axillary line but in the tenth interspace. (Site of osteomyelitis of the ribs.) The right side of the chest wall was essentially normal. On the left side, there were diminished breath sounds from about the fifth interspace downward anteriorly and posteriorly. Emphysematous breath sounds were heard above this area with increased resonance to percussion. In right lung fields there were increased resonance and slightly increased emphysematous breath sounds. No hepar, spleen or masses were palpable, and no clubbing or cyanosis was visible in the extremities.

Impression: Tuberculosis of left lung with mixed empyema and osteomyelitis of the seventh, eighth, and ninth ribs anteriorly.

A plastic revision of the chest wall with removal of osteomyelitic seventh, eighth, and ninth ribs anteriorly was carried out on May 25, 1944.

CASE XIII. H. S. was a sixty year old white male with a history of pneumonia on the right side. He developed a most massive empyema which was drained by a closed thoracotomy. The patient became incontinent and irrational, and pulled the tube out which was replaced.

Physical examination revealed a febrile, critically ill, aged white male with extremely massive empyema which displaced the trachea and mediastinum excessively to the contralateral side. Examination of the chest revealed occasional extra-systoles and poor heart sounds. The apex beat was at the sixth interspace, almost anterior axillary line, on the left side. The hepar was about two fingers down. Two plus edema of the legs was present.

Impression: Massive postpneumonic empyema with anasarca due to hypoproteinemia.

The patient expired after reinstallation of the thoracotomy tube, and before adequate high protein replacement by debilitated vitiated tissues could be achieved.

CASE XIV. C. R. was a three one-half year old Filipino female with a history of pneumonic process in the left chest, particularly of the upper lobe. Moot etiology of ingestion of oily nose drops was obtained from the mother. The probability of a lipoid pneumonia by aspiration was considered, particularly since the bizarre x-ray picture suggested an atypical pneumonitis with probable cystic lung background. An empyema of an interlobar nature followed on this left side. Repeated chest aspirations and replacement in a like quantity with penicillin plus intramuscular injections of penicillin was done unsuccessfully. A closed thoracotomy in the eighth interspace anteriorly, axillary line, was done on July 29, 1944. After a few days the drainage material became thick and inspissated. An open thoracotomy was then done on August 28, 1944. Removal of  $2\frac{1}{2}$  inches of the eighth and ninth ribs in the anterior axillary region was then done to increase drainage. Packings with crude penicillin have been inserted to date.

Physical findings on admission showed the patient to have a low grade fever and to be slightly cyanotic. All findings were essentially negative except for slight dullness and bronchovesicular breathing over the left lower chest posteriorly below the scapula.

Physical findings after operation were as follows: Temperature, pulse and respirations normal; no cyanosis or dyspnea present.

There was a small sinus in the eighth interspace, anterior axillary line, on the left side, draining a very small amount of thick pus with *Staphylococcus aureus* the predominant organism. The cicatrix around the sinus was healing slowly but well. Breath sounds were still bronchovesicular, but over the area which was drained dullness still persisted. X-ray findings suggested a lung abscess at the base of the left lower lobe and the rib resection with resultant pneumonitis and very small residual empyema present. The rest of the left lung still showed cyanotic mottling. The right lung was essentially normal.

CASE XV. S. R. was a thirty-seven year old colored female with a twelve year history of bilateral pulmonary tuberculosis. Bilateral pneumothorax treatments were instituted, the right side in 1934 and the left side in 1939. Despite left-sided treatments large cavitation of the left apex of the lung developed with persistent high tubercle bacilli in the sputum. Increasing sepsis in the form of continued temperature and finally hoarseness due to tuberculous invasion of the larynx occurred. Since a right Jacobaeus had been done in 1938 and a left Jacobaeus in 1940, with this bilateral problem a cavernostomy on the left side for this apical cavity was advised and the patient was admitted for same.

On admission the patient was only semi-ambulatory, dyspneic on very slight exertion, running a temperature of about 101 to 102°F. with hoarseness. There was slight cervical adenopathy on both sides; the trachea was deviated moderately to the right side. Larynx and vocal cords, examined by direct laryngoscopic study, revealed grayish exudate in tubercles on the mucous membrane. The systolic murmur over the precordium in a diffuse nature.  $A^2 = P^2$ . There was diminished expansion over both lung fields with emphysematous breath sounds at both bases. Bronchial breathing was heard over the left lung posteriorly between the fifth and eighth spaces along the vertebral border of the scapula. There were no masses, liver or spleen palpable. There was slight clubbing of the extremities but no cyanosis or edema.

Impression: (1) Bilateral pulmonary tuberculosis with bilateral pneumothorax; (2) cavitation of the left apex located posteriorly between the fifth and eighth ribs.

X-ray studies showed bilateral advanced

tuberculosis of caseous pneumonic type with bilateral pneumothorax and a giant cavity involving the larger portion of left upper lobe of the lung posteriorly.

Cavernostomy at the sixth interspace on the left side about 4 cm. from vertebral column posteriorly was carried out on October 16, 1944. The patient developed increased dyspnea with slight effusion postoperatively about ten days. She then made a slow but steady recovery to date.

#### PROTEIN CONTENT, PLEURAL EFFUSIONS AND EMPYEMA

| Condition  | Proteins,<br>Per Cent |
|--|-----------------------|
| 1. Esophagostomy (for megalo-esophagus) postoperative..... | 7                     |
| 2. Lobectomy (postoperative).....                          | 4                     |
| 3. Pneumococic empyema.....                                | 3.6 to 5              |
| 4. TB mixed empyema.....                                   | 5 Average             |
| 5. TB effusions after Jacobaeus operations.....            | 4 to 10 Average       |
| 6. Pleural effusion with cardiac de-compensation.....      | 4 to 6                |
| 7. Fluid from pericardiotomy.....                          | 0.8                   |

These statistics include values from the fifteen cases listed in this article and a compilation of chemical values obtained in chest aspirations from the male and female medical wards of Metropolitan Hospital. Thirty-one chest values are used as a basis for the above figures. All other chest aspirations which were contaminated or had the admixture of blood due to trauma were discarded.

The estimation of protein was done quantitatively by a method of precipitation with sulfosalicylic acid and reading the photoelectric calorimeter.

The gross appearance of pleural fluid insofar as apparent viscosity and its rapid adhesive and clotting effect is not always a direct function of the total protein value obtained. A more accurate coefficient is the amount and type of fibrinogen in the fluid relative to the total protein. Since the efficacy of drainage depends all too frequently upon free flow of fluid without clogging of the thoracotomy tube, this latter effect is now being investigated and will be reported in the next article on this subject.

## CONCLUSIONS

1. Hypoproteinemia in patients with intrathoracic disease is insidious in onset and course, progressive in character, and severe in its dire implication.

2. The lowering of the plasma protein is largely consequent upon the amount and type of intrapleural formation. (Percentages of protein varying from 4 to 7 per cent.)

3. Alteration of protein balance is moderated by the extent, type, and severity of operation manipulation procedure on pulmonary tissue.

4. Anticipation of large postoperative protein depletion and rapid restoral by the intravenous route (amino acids, whole blood plasma) fortified by oral ingestion is suggested as routinely as postoperative oxygen.

5. The amount of protein replacement may be calculated by the positive loss (total protein preoperatively minus postoperative blood protein and multiplying the difference by 5,000) plus the twenty-four-hour amount of fluid in the chest times per cent protein per cc. Each time the total protein value is taken its relative verity must be checked for anhydremia by red blood count or value.

## SUMMARY

1. A preliminary investigation into the value, extent, and correction of hypoproteinemia in thoracic surgery is here presented.

2. The cases in this article, some fifteen in number, have been deliberately selected as they occurred in our regular ward service without any attempt carefully to pick or color desired statistics or results. It may be added at this point that every one of our cases has come from other institutions where previous corrective attempts were either ineffectual or only partially successful. Thus all of our cases represent very good test cases for the bad risk, the poorly prepared patient, and

finally those on whom all too frequently the imminence of fatality vies with the necessity for exposing that patient to operative correction.

3. It is our intention to emphasize the necessity for the use of parenteral protein intake along with the importance of recognition of protein loss in internal accumulation of pleural fluids.

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ANEMIA is a common feature of toxemia of pregnancy. If anemia is present to any degree, blood transfusion is indicated prior to any type of operative intervention.

From "The Management of Obstetric Difficulties" by Paul Titus (C. V. Mosby Company).

# THE USE OF FREE OMENTAL GRAFTS IN THE THORAX\*

## AN EXPERIMENTAL STUDY

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THE use of free omental grafts in abdominal surgery dates back to the time of Nicholas Senn in 1887.<sup>1</sup> Since that time free omental grafts have been used in several areas of the body other than the abdomen.<sup>2</sup> We have not found, however, any report in the literature on the use of free omental grafts in the thorax.

It is the purpose of this report to give the results of animal experiments in which free omental grafts were used in the thorax, and to describe the manner in which the experiments were performed. The general scope of this work was to determine the fate of the free omental graft in the thorax, and also to determine its value and possible uses.

Dogs were used exclusively. There were 116 experiments performed upon sixty dogs. Some of the dogs died of various causes. Because of many handicaps all of the animals that died were not autopsied; however, only those experiments are reported herein which were performed upon animals which were subsequently autopsied or re-operated.

### TECHNICAL PROCEDURE

The dogs were anesthetized with nembutal (veterinary) given intraperitoneally. The abdomen and one side of the chest were then shaved. An endotracheal tube with occlusion cuff was inserted into the trachea to provide a method of pulmonary ventilation as well as a means of re-expanding the collapsed lung at the end of the operation. A small paramedian incision

was made in the abdomen to obtain the omental graft. The distal edge of the greater omentum was used and a v-shaped graft was excised. No attempt was made to protect or roll in the cut edge of the donor surface. After obtaining the graft it was placed upon a wet gauze pad for immediate use or in a sterile saline or sterile Ringer's solution and stored in the icebox for future use.

The abdominal incision was closed and a thoracic incision was made in the sixth or seventh intercostal space and the thorax opened widely. Because of the thin and sometimes imperfect mediastinal partition in dogs, both lungs may collapse upon opening the chest and it is necessary to provide artificial pulmonary ventilation. This was done by the rhythmic compression and relaxation of an anesthetic bag filled with oxygen. One end of the bag was attached to the endotracheal tube. A blow-off valve prevented the accumulation of carbon dioxide.

The free omental graft just obtained or previously obtained from another dog and preserved was applied to the desired site and held in place by silk sutures or by plasma glue. The thoracic incision was closed after the lung was completely inflated. The animals were re-operated upon or autopsied at intervals of twenty-four hours to twelve weeks.

### FATE OF THE FREE OMENTAL GRAFT IN THE THORAX

Because of the pliability the graft readily lends itself to close apposition to

\* From the Surgical Research Laboratory of the New York Medical College, The Flower and Fifth Avenue Hospitals. Aided by a grant from the Committee on Scientific Research of the American Medical Association.

any contour or surface; and if held lightly in place for a few minutes, it tends to adhere to the surface of the structure. At the end of twenty-four hours the graft is attached lightly and has a whitish rather than pink color. At the end of forty-eight hours the graft is definitely adherent and the fatty tissue in the graft has a whitish color. When the graft is separated, there is a granular surface at the site of attachment. At the end of seventy-two hours the graft is more firmly adherent and capillary oozing occurs upon separation of the graft.

At the end of one week the graft is firmly adherent and can be separated with difficulty. There has been some absorption of the fatty tissue in the graft which now appears to be smaller in size and has a grey-pink color. At the end of three weeks the graft is firmly adherent and cannot always be separated. Bleeding occurs freely upon separation. The fatty tissue in the graft is largely absorbed and the graft has taken on an appearance similar to the surface of its host. At the end of twelve weeks the graft can be seen with difficulty and occasionally can be identified only by its silk suture attachments. The fatty tissue has been completely absorbed. The graft is thin and almost identical in appearance to the surface of its host.

Failure of the graft to adhere and become viable (take) occurred four times in eighty-seven experiments (5 per cent). In three of the four failures the cause was attributed to infection. However, the presence of infection in more than four other experiments did not prevent the take of the graft. Two of the unsuccessful grafts were anchored with sutures and two were anchored by means of plasma glue. Three of the failures were autogenous grafts and one was homologous.

#### FREE OMENTAL GRAFTS ON THE PLEURA

The graft was anchored to the visceral as well as the parietal pleura, over the inner chest wall and the diaphragmatic surface. At times the pleura was roughened

by scraping with gauze before the graft was applied and at other times no scarification was done. In this series of thirty-five grafts upon the pleura there were four failures of the graft to become viable.

Microscopic study shows a thin zone of fibrin and hemorrhage between the adipose tissue of the graft and the pleural surfaces. The pleural endothelium is not seen. The subendothelial connective tissues are swollen and hemorrhagic. Throughout the adipose tissues of the graft there are small foci of fat necrosis. Red blood cells are seen in many of the vessels of the adipose tissues.

#### FREE OMENTAL GRAFTS ON THE CUT SURFACE OF THE LUNG

The lung was scarified and cut with the scapel. The incisions were perpendicular and tangential to the lung surface for a depth of  $\frac{1}{32}$  to  $\frac{1}{4}$  of an inch. This produced bleeding and multiple alveolar lacerations. The free omental graft was applied and held in place by means of silk sutures placed at the edges of the graft. Bleeding was completely controlled and no bronchopleural fistulas developed. There were no failures of the graft to become viable in ten experiments.

Microscopic study shows focal fibrinous and hemorrhagic reactions between alveolar and adipose tissues of the graft. Also slight focal fibrosis was noted. Alveolar tissues collapsed and were hemorrhagic. In the regions of the small bronchioles and terminal bronchioles there is a moderate fibrinous and polynuclear cell inflammatory reaction.

#### FREE OMENTAL GRAFTS ON THE CUT EDGE OF THE LUNG

A presenting lobe was amputated approximately at its distal third. There was no preliminary clamping of lung tissue or blood vessels to control hemorrhage. This partial amputation of the lobe produced many bleeding vessels some of which were pumping in character. Also many bronchae and alveolae were opened.

The graft was applied to this raw and bleeding surface and held lightly, with only enough pressure to keep the graft from being dislodged by the pressure from the bleeding vessels. The graft is extremely pliable and adaptable and fits snugly into small crevices and across the opening of the small bronchae, blood vessels and alveolae. The graft was held in place for varying periods of no more than three minutes. At the end of this time the graft was molded to the contour of the cut edge of the lobe and all bleeding was completely

separately. The bronchus was clamped and cut across, thus performing a lobectomy or pneumonectomy. The bronchial stump was closed by a single surrounding ligature of silk or was closed by mattress sutures which brought the posterior surface into contact with the anterior surface. A free omental graft was placed over the stump of the closed bronchus, very much in the manner of a cap and held in place by silk sutures. The graft was definitely a factor in the prevention of bronchial fistulas since some of the bronchial stumps were closed so loosely that they were not completely airtight before the graft was put in place. There were no bronchial fistulas and no graft failed to take in ten experiments.

TABLE 1  
FREE OMENTAL GRAFTS

| Site                           | No. | Fail-ures | Per Cent* |
|--------------------------------|-----|-----------|-----------|
| Pleura.....                    | 35  | 4         | 11        |
| Cut surface of lung.....       | 5   | 0         | 0         |
| Cut edge of lung.....          | 5   | 0         | 0         |
| Stump of bronchus.....         | 10  | 0         | 0         |
| Esophagus.....                 | 14  | 0         | 0         |
| Vena cava.....                 | 3   | 0         | 0         |
| Aorta.....                     | 3   | 0         | 0         |
| Cut lung for hemostasis.....   | 12  | 0         | 0         |
| Total number.....              | 87  | 4         | 5         |
| Number of autogenous grafts... | 70  | 3         | 4         |
| Number of homologous grafts... | 17  | 1         | 6         |

\* Percentages approximate.

stopped. It is an amazing sight to see a pumping vessel on the cut surface of the lung completely controlled by the light application of an omental graft. The use of an omental graft on the lung for hemostatic purposes has not been mentioned previously. The graft was anchored by interrupted black silk sutures around its edge only. No attempt was made to use hemostatic sutures. The grafts remained in place and became viable. There was no secondary bleeding and no bronchopleural fistulas developed in four experiments.

FREE OMENTAL GRAFTS ON THE BRONCHIAL STUMP

A lobe bronchus or the main bronchus was isolated. The branches of the pulmonary artery and veins were ligated

FREE OMENTAL GRAFTS ON THE ESOPHAGUS

The esophagus was exposed by a left thoracic approach and free omental grafts were placed around the esophagus without any anchoring in some experiments and in others the graft was anchored with silk sutures. In some experiments the esophagus was freed and cut across in its lower one-third. Approximately one-half inch of the esophagus was excised. The cut edges were then approximated and the esophagus was united by an end-to-end anastomosis. The suture line was reinforced by wrapping a free omental graft around the esophagus at the site of the anastomosis and anchoring it with silk sutures. These dogs were allowed fluid by mouth freely at the end of twelve hours after the operation and soft food was allowed on the second postoperative day.

The grafts which were applied to the muscular coat of the intact esophagus became viable whether anchored by suture or not. There were no failures in nine experiments. Marked fibrinous reaction was seen on microscopic study between adipose tissues of the graft and adventitia of esophagus. Focal fibrosis between omental and connective tissues of the esophagus was also noted. In addition one slide shows small foci of granulation tissue between the adipose tissues and the adventitia of the esophagus.



The graft used to reinforce the suture line of the end-to-end anastomosis of the esophagus became adherent and viable and was a definite factor in the success of the anastomosis by preventing leakage. We believe that this is an important observation since the end-to-end esophageal anastomosis is a notorious failure due to leakage at the suture line with secondary infection. There were no failures of the graft to take; however, leakage at the suture line did occur once in five experiments.\*

#### FREE OMENTAL GRAFTS ON THE AORTA AND VENA CAVA

The descending aorta was exposed by a transthoracic approach. The overlying pleura was incised and approximately one or two inches of the anterior and lateral surfaces of the aorta was exposed. A free omental graft was then applied to the vessel and held in place by suturing to the surrounding structures. The graft became adherent and viable.

The inferior vena cava was exposed and stripped of its pleural covering. A free omental graft was applied to the vessel and held in place by sutures to the surrounding structures. The graft became adherent and viable. There were no failures of the graft to take in three experiments upon the aorta and three upon the inferior vena cava.

#### AUTOGENOUS, HOMOLOGOUS AND PRESERVED GRAFTS

We were unable to note any particular difference between the action of autogenous and homologous grafts insofar as hemostatic effect and viability were concerned. Of the four failures of the graft to become viable three of these were autogenous and only one was homologous. This series is too small for definite conclusions, although we believe that homologous grafts take as well as autogenous. Eight of the grafts were preserved in sterile saline or Ringer's

solution and stored in the icebox. Four grafts were preserved for twenty-four hours. Two were preserved for one week and two for two weeks. All preserved grafts were homologous and all were successful takes. We were unable to note any particular difference between the hemostatic action and viability of the immediate graft and the preserved graft.

#### COMMENT

These experiments show that free omental grafts, when applied to such thoracic structures as the pleura, the cut surface and edge of the lung, the bronchus, the esophagus, the aorta and vena cava, will become adherent and viable in a large percentage (95 per cent). Four of the grafts in this series of experiments failed to take. Three of the graft failures were autogenous (4 per cent) and one was homologous (6 per cent). In two of the failures the graft was anchored to the surface of the lung by a plasma glue, which perhaps is not a fair method of determining viability because of the constant movement of the lung. Three failures occurred in the presence of infection; however, infection was present in six other experiments in which the graft did become viable. Therefore, in the presence of infection the graft became viable in 60 per cent.

The possible uses of free omental grafts in the thorax are: hemostatic effect, reinforcement of suture lines, and replacement of defects.

The hemostatic effect of the free omental graft has been known for some time. In 1906, Lowe<sup>3</sup> reported controlling hemorrhage of the liver with free omental grafts. The ability of an omental graft to control a spurting branch of the pulmonary artery by simple application with gentle pressure for three minutes is very dramatic. This property has definite clinical value.

The ability of a free omental graft to adhere and become viable over a suture line, thereby reinforcing and adding an extra layer of tissue, is probably the

\* We are indebted to Dr. Frank D. Speer for his co-operation and assistance in the preparation and report of the microscopic slides.

outstanding value of the graft. The clinical application of this property in the closure of bronchial stumps and around an end-to-end anastomosis of the esophagus would seem to have great value.

It is admitted that the one great disadvantage of using free omental grafts in the thorax is the inaccessibility of the graft. For autogenous grafts this means opening the peritoneal cavity. Whether through the abdomen or the diaphragm, this is an added surgical procedure.

However, from our experiments on dogs it would seem that there is little difference between the action of autogenous and homologous grafts, and furthermore homologous grafts can be preserved for at least two weeks (probably longer) without affecting its viability or hemostatic effect.

The acquisition and preservation of homologous omental grafts does not present any problem in the modern hospital. In these days of blood banks, skin banks, and eye banks, the establishment of an omental bank does not need to stretch the imagination.

#### CONCLUSIONS

A series of animal experiments were performed to determine the fate of free omental grafts in the thorax and their possible value.

The free omental graft readily becomes adherent to the surface of such structures as the pleura, the cut surface and cut edge of the lung, the cut end of a bronchus, the aorta and vena cava. It becomes viable and takes in a very large percentage.

The free omental graft can be used to cover defects, to reinforce suture lines, and produce hemostasis. It is particularly useful to stop hemorrhage from the lung, to cover a bronchial stump and prevent the development of a bronchial fistula, to reinforce and prevent leakage from the suture line of an end-to-end anastomosis of the esophagus.

There appears to be no clinical difference between the action of autogenous and homologous free omental grafts in the thorax, and the homologous graft can be preserved for at least two weeks (probably longer) without impairing its usefulness.

The securing of an autogenous omental graft means opening the peritoneal cavity, but in the modern hospital securing homologous omental grafts is easily accomplished from any clean abdominal operation.

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# CONSTANT TRACTION DRESSING\*

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THE tendency of traumatic wounds to gape is due rather to the elasticity of the tissues pulling the wound open comfortable than the usual gauze dressing. (2) The change of dressing was atraumatic and painless. (3) When the raw surface

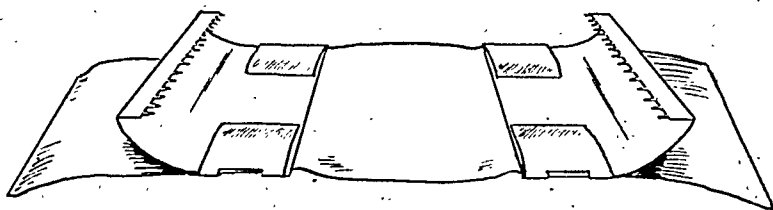


FIG. 1. Showing undersurface of the dressing. In applying it the trailing edges of fabric are grasped, the dressing is stretched, and the spurs engaged in the skin close to the opposing wound margins.

than to actual loss of tissue. During the time which elapses while such a wound is being prepared for secondary closure, the tissues, particularly the skin, become partially fixed in the gaping position so that when the wound is ready for closure, approximation may be difficult. In treating gunshot wounds during the early phase of the Solomons' campaign, one of us was impressed by the desirability of a dressing which would maintain gentle and continuous traction on the skin edges and which at the same time would prevent gauze from coming in contact with the raw surface. At that time attempts were made to accomplish these objectives by stretching a sheet of perforated rubber dam across the wound and fastening it with adhesive tape applied to the skin margins.

This type of dressing had the following advantages: (1) The dressing was more

of the wound was thus protected from irritating contact with the overlying gauze dressing, discharge was materially lessened. (4) The skin edges underwent a progressive approximation, yielding a narrower scar and in some cases avoiding the necessity of secondary suture and skin grafting.

The chief disadvantage of this dressing was that it was difficult to maintain in position because the traction of the rubber dam caused the anchoring adhesive to slide upon the skin.

Our efforts have since been directed toward devising some substitute for surgical adhesive tape which would not slide on the skin under the stress of continuous traction. The dressing shown in the accompanying illustrations was finally evolved. It consists of two metal members connected by a sheet of latex. The metal

\* The opinions and assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

members are fabricated from a sheet of stainless steel 0.004 inch thick. The spurs on the metal members are 0.02 inch in

properly applied, the dressing will not come loose until the wound is sufficiently narrowed to release the traction which



FIG. 2. A, a gaping wound of the scalp after excision of traumatic arteriovenous aneurysm. B, constant traction dressings applied; C, the wound four days later.

length, short enough so that they penetrate only the tough stratum corneum and do not cause pain, bleeding, or inflammatory reaction. The spurs are very sharp and are set  $\frac{1}{20}$  inch apart. The single row of spurs can be attached to the skin close to the wound margin, so that there is little tendency for inversion of the skin edge. The metal members are all 1 inch wide, but the elastic portion is made in various lengths for wounds of various sizes. Shorter dressings may be applied as the approximation of the skin edges proceeds. If

keeps the spurs buried in the stratum corneum. However, contact of the latex portion of the dressing with wound secretions for four or five days does cause some reduction in its elasticity.

The ability of the skin to elongate itself under the influence of continuous traction is demonstrated by the Ubangi natives, who for centuries have stretched their ear lobes and lips by hanging pendants. A constant traction dressing properly applied makes this property of the skin available to the surgeon.



# Case Reports

## BENIGN GIANT CELL XANTHOMA OF THE KNEE JOINT

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**T**UMORS of the synovial membrane of the joints are relatively uncommon, and of the various primary benign tumors of the knee joint xanthoma is the most common. Nevertheless comparatively few cases have been reported in the medical literature.

The first case reported in the medical literature was described by Gustav Simon<sup>1</sup> in 1865; since that time cases have been reported from time to time and in 1939 De Santo and Wilson in reviewing the literature reported thirty-six cases. They were of the opinion that xanthomas of the knee joint are of more frequent occurrence than the reports would indicate.

It is seldom that the diagnosis is made preoperatively. The condition is said to be more common in men than women. An associated disturbance in lipoid metabolism has been occasionally noted as evidenced by the elevated blood cholesterol. The tumor mass is usually solitary but may be multiple and is usually found attached to the synovial membrane at or near the medial meniscus. Grossly the tumor is rounded or spheroidal and is usually golden yellow orange in color, studded with darkened areas representing old or recent hemorrhage. Histologically, an area of synovial-membrane mesothelium may be found surrounding the tumor mass in which any of the following type cells may be found: foam cells, fibrocellular stroma and multinucleated giant cells. Coarse yellow or brown particles of hemosiderin are present scattered throughout the field. Recurrences of the tumor have been described and have been attributed

to incomplete removal or to later development of a small undiscovered tumor. No instance of a benign giant cell xanthoma undergoing malignant transformation has ever been reported. Treatment is wide surgical extirpation. A case report with gross and microscopic features are presented.

### CASE REPORT

The patient was twenty-two years old and was admitted to the surgical service because of acute appendicitis. An appendectomy was performed and he made an uneventful recovery.

During the third week of convalescence he complained of pain and locking of the right knee joint with no history of old or recent trauma, followed two weeks later by further locking of the right knee joint in flexion. He also stated that he could feel something moving around within the knee joint. Examination failed to reveal any limitation of motion at the knee joint, swelling or local heat, nor could any measurable quadriceps atrophy be demonstrated. There was no antero-posterior or lateral instability present. A small irregular mobile palpable mass about 1 cm. in diameter could be palpated at the anteromedial aspect of the joint. The clinical impression was that of a loose body within the knee joint, probably a "joint mouse." Roentgenographic studies of the knee revealed no evidence of a loose body within the joint cavity. Blood count, urinalysis and blood Kahn tests were reported as normal.

On the basis of a palpable mass within the joint surgical exploration was undertaken through a medial parapatellar incision. Upon opening the synovia, a small amount of yellow orange fluid escaped. A small pedunculated tumor mass 2.5 by 1.0 by 0.4 cm., attached to the synovia on the medial side of the right

knee joint just above the articulation presented itself. The mass was gray brown in color and on section revealed tissue of an orange brown

Macroscopically (Fig. 1) the specimen consists of two masses of tissue, the larger of which has a yellow color and a shiny, white



FIG. 1. Benign giant cell xanthoma of the knee joint; gross specimen.



FIG. 2.—Benign giant cell xanthoma of knee joint; microscopic section.

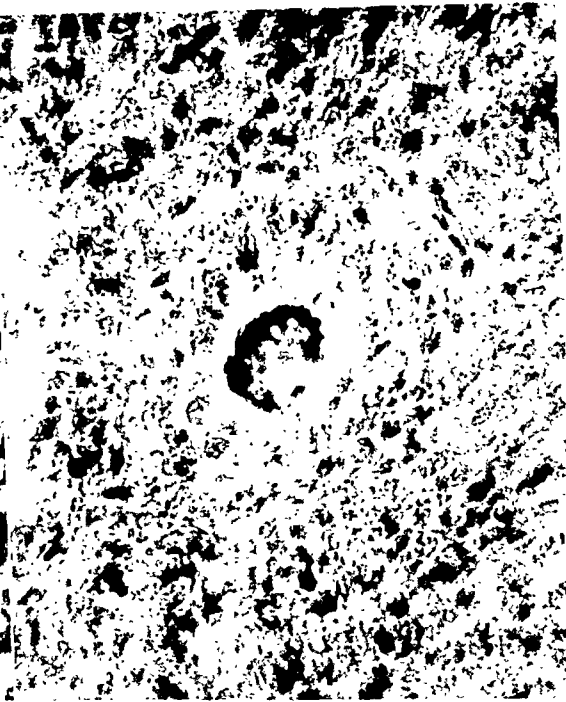


FIG. 3.—Benign giant cell xanthoma of knee joint; microscopic section.

color, throughout which were scattered areas of a darker brown. The tumor was resected and a wide base of normal appearing tissue was removed with the mass. The defect in the synovia was closed and the patient made an uneventful recovery. Blood cholesterol studies were done postoperatively and were reported as 207 mg. per 100 cc.

capsule. The larger mass measures 2 by 1.5 by .4 cm., and appears to be a flattened sphere with a rounded superior portion and a narrowed base. On section the stroma is composed of areas of whitish-gray, fleshy tissue mixed with other areas of yellow staining, irregular masses. No pus can be expressed from this mass. Impression: Xanthoma of knee joint.

Microscopically, (Fig. 2) the section shows cellular tissue, with fibroblasts, epulis-like giant cells, and a few dilated capillaries. Patches of hemosiderin pigment are noted, as well as sheets of large lipoid containing cells. (Fig. 3.)

Diagnosis: Giant cell tumor-xanthoma variant.

We believe this case is of interest because of the following: (1) Its relatively infrequent occurrence. (2) Three weeks elapsed between the time of the patient's first complaints referable to his right knee and the time of surgical removal. (3) X-rays were of little value in making the diagnosis and the fact that they were non-revealing in the presence of clinical findings should make one suspicious of a neoplasm within the knee joint.

#### SUMMARY

1. A case of benign giant cell xanthoma has been reported.

2. Gross and histologic features have been presented.

3. Treatment is wide surgical extirpation.

4. In no instance has malignant transformation been reported.

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# POSTOPERATIVE THROMBOSIS OF THE ILIAC VEIN\*

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THE threat of postoperative and puerperal thrombophlebitis hangs constantly over the surgeon's and accoucheur's head. The following case report of postoperative thrombosis of the iliac and tributary veins is, therefore, presented and its treatment is discussed.

## CASE REPORT

Mrs. A. R., a twenty-five year old Caucasian, first came to the obstetrical department of The Clinic for prenatal care on October 5, 1943. She had had an appendectomy and a "scraping of the right ovary" seven years previously and an attack of pyelitis five years previously. Since the attack of pyelitis she had been known to have a ptotic right kidney. Intravenous pyelograms taken on August 9, 1943, showed prolapse of the right kidney with slight hydronephrosis. Her last menstrual period had begun on August 24, 1943. General physical examination was entirely normal except for evidence of pregnancy. Her blood pressure was 110/78, and urinalysis was normal.

Her pregnancy progressed uneventfully until February 29, 1944, when she returned for a periodic prenatal examination at the sixth month. She had at that time noticed puffiness of the hands and feet and had had mild headaches. There were no visual disturbances. Examination revealed an 11 pound weight gain in three weeks, marked pitting edema of the feet and ankles and edema of the hands and eyelids. The blood pressure was 140/90. Urinalysis showed 4 plus albuminuria but no acetone, acetic acid, blood or casts in the urine. The patient was admitted at noon of the same day to the hospital. Treatment consisted of bed rest; a low salt, high protein diet; ammonium chloride and magnesium sulfate orally; sedation in the form of pentobarbital orally; and 500 cc. of 20 per cent glucose intravenously. Plasma proteins were 5.3 Gm. per 100 cc. At 6:40 P.M., a plasma infusion was begun but the patient had a severe urticarial reaction about the face and chest within twenty minutes, and

the infusion was stopped after less than 50 cc. had been given. At 7:30 P.M. there was a moderate urticaria of the face and chest. The patient complained of a severe headache but had no aura. She had vomited once and felt nauseated. Her temperature was 100°F.; her pulse rate was 110 per minute; and the blood pressure was 174/110. It was believed that most of the symptoms and signs were due to fulminating pre-eclampsia rather than the anaphylactic reaction, especially in that the blood pressure had risen steadily during the afternoon. Pelvic examination revealed a rigid, elongated cervix with inaccessible membranes. It was believed that interruption of the pregnancy by hysterotomy under local anesthesia was indicated in order to prevent full-blown eclampsia.

Inasmuch as the pregnancy was of only six months' duration, 3 g. of pentobarbital orally and  $\frac{1}{6}$  g. of morphine subcutaneously were given for pre-anesthetic sedation. Novocain, 1 per cent, locally, was used as the anesthetic agent. A classic cesarean section was done, and the patient delivered of a female which lived only a few minutes. Pitocin, 1 cc., was injected into the uterine musculature and 0.2 mg. of ergotrate was given intravenously after the delivery of the placenta. Blood loss was minimal.

By the next morning the patient looked much improved and her blood pressure was 140/100. She improved rapidly and was far more cooperative than the average patient in moving about the bed and in exercising her legs and feet. Sutures were removed from the wound, which healed per primum, on the seventh postoperative day. She dangled her legs over the bed on the same day and was up in a chair on the eighth day, walked on the ninth day, and was discharged home on the tenth postoperative day. During her convalescence there were no symptoms or signs of deep phlebitis of pelvic or leg veins. Her blood pressure on discharge was 138/80, and urinalysis revealed only a trace of albumin.

The patient was next seen at home on March 23, 1944, twenty-three days after the hysterot-

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omy and thirteen days after discharge from the hospital. She stated that she had been well and had been up and about the house until



FIG. 1. Photograph of patient taken one month postoperatively. Note absence of edema and venous dilatation.

three days previously (March 20th) when she began to have pain in the left calf. The pain became increasingly severe during the following three days and forced her to go to bed as walking was unbearable. She had not felt feverish at any time nor had she had any chill. Examination revealed pitting edema of the left lower leg and moderate swelling of the left thigh without heat or redness. The left calf was tender as was the course of the femoral vein up to the inguinal ligament. Dorsiflexion of the foot elicited severe pain in the calf. There was no abdominal tenderness and the abdominal wound was well healed. The temperature was 100.6°F.

Two hours later the temperature had risen to 101.6°F., but otherwise the findings had not changed. There was no tenderness above the inguinal ligament nor was there any rectal tenderness. It was believed that the patient had a thrombosis and possible phlebitis of the left femoral vein and its branches and that prompt ligation of the femoral vein proximal to the thrombosis might well prevent a fatal pulmonary embolus.

Under spinal anesthesia with 10 mg. of pontocaine a longitudinal incision was made over the junction of the left saphenous and femoral veins. Both were found completely thrombosed, the latter up to the inguinal ligament. A left supra-inguinal incision was then made and the retroperitoneal region exposed. All the deep veins of the pelvis on the left side, including the femoral, hypogastric, and external and common iliac, were completely thrombosed up to the bifurcation of the inferior vena cava. There was massive edema about these veins. The left common iliac vein was inadvertently opened and a small amount of serous whitish fluid extruded. This was cultured. The clot in this vein seemed poorly attached to the vein wall.

The left common iliac vein was then doubly ligated with No. 1 chromic catgut at its junction with the vena cava. The left sympathetic chain was located and about one inch of it, including the fourth or fifth lumbar ganglion, was removed. Six Gm. of crystalline sulfanilamide, along with two soft rubber drains, were inserted and the wound was then closed in layers with No. 0 chromic catgut.

The spinal anesthetic was supplemented with cyclopropane and oxygen inhalation anesthesia. One thousand cc. of citrated banked blood was given intravenously during and immediately following surgery. Following surgery 2.5 Gm. of sodium sulfadiazine and also 20,000 Toronto units of heparin dissolved in 1,000 cc. of saline were given intravenously over a three-hour period. Wangenstein suction was instituted. The postoperative condition was fair.

On the morning of the first postoperative day the temperature was 99.6°F., the pulse 136, and the patient's general condition was improved. Clotting time was five minutes. The blood count showed 4,450,000 red cells, hemoglobin 84.6 per cent (11 Gm.), white cells 13,200, with 92 per cent polymorphonuclear leukocytes. Wangenstein suction was discontinued and a light diet was given. One Gm. of sulfadiazine and 0.6 Gm. of bicarbonate of soda were given orally every four hours. Then slow intravenous drip of 30,000 Toronto units of heparin in 1,000 cc. of normal saline was begun.

The blood clotting time at noon was over two hours. Before this had been reported, the patient had been given 300 mg. of dicumarol by mouth, but had vomited most of it shortly

afterward. At this time the wound began to discharge a large amount of bright red blood. The patient was immediately given 1,000 cc. of citrated banked blood. Five hours later the clotting time was twenty-three minutes but the prothrombin level was so low that it could not be determined. Large doses of vitamin K were given intramuscularly, and another 500 cc. of citrated banked blood was given. The patient's condition was fair despite a large amount of blood loss from the wound. There was no evidence of bleeding elsewhere. Because of vomiting sulfadiazine was given by vein instead of by mouth. The wound culture taken at operation was now reported as showing "only a few streptococci."

By the next morning, the second postoperative day, the clotting time was five minutes, the prothrombin level 73 per cent of normal, the red blood count 3,360,000, hemoglobin 66.7 per cent (8.8 Gm.), white count 12,250 with 85 per cent polymorphonuclear leukocytes. Bloody serum only was discharging from the wound, though it was evident that the patient had a large wound hematoma. The temperature was 101°F., pulse 130. The patient looked and felt well and was hungry. She was urged to swing her feet over the side of the bed and to exercise vigorously the contralateral leg, especially by plantar flexion and extension exercises.

On the morning of the third postoperative day the clotting time was five minutes but the prothrombin level had dropped to 56 per cent of normal, probably due to the delayed effect of the small amount of dicumarol she had retained two days previously. Her sulfadiazine level was 12 mg. per 100 cc. of blood. Urinalysis was normal. Oral sulfadiazine was resumed at this point in place of the intravenous. On the fourth postoperative day the clotting time was four minutes and the prothrombin level was normal.

Up to and including the sixth postoperative day, the temperature remained in the vicinity of 101°F., and on that day the red blood count was 1,830,000 hemoglobin 41.5 per cent (5.4 Gm.), white blood count 16,300 with 79 per cent polymorphonuclear leukocytes. Urinalysis was normal. It was believed that the anemia was due to sulfonamide sensitivity as there had been no recurrence of fresh bleeding from the wound or elsewhere. The wound was discharging syrupy black blood only. Accordingly, the

sulfadiazine was withdrawn and a 1,000 cc. transfusion of citrated banked blood given. The following day the temperature fell to a normal level where, with slight variations, it remained for the rest of the hospital stay.

On the eleventh postoperative day the sutures were removed and the patient sat in a chair; she walked on the twelfth postoperative day. On the fifteenth postoperative day the red blood count was 3,350,000 and the hemoglobin 76 per cent (9.9 Gm.). At this time the edema of the left foot, leg and thigh which had been marked began to regress. When the patient was discharged home on the twenty-fifth postoperative day, with minimal wound drainage, she had only slight edema of the left leg and foot, and was able to walk without difficulty. She was seen at regular intervals at the office and convalescence continued uneventfully. A photograph taken on April 27, 1944, (one month postoperatively) shows practically no difference in size of the two legs. The edema had entirely disappeared. (Fig. 1.)

#### COMBINED USE OF HEPARIN AND DICUMAROL

The use of anticoagulants without surgery in the prevention of venous thrombosis, extension of venous thrombosis, and pulmonary embolism has recently received considerable attention.<sup>1,2</sup> Statistics point to a greatly reduced incidence of initial or repeated pulmonary embolism in patients under fifty years of age treated with anticoagulants alone. Patients over fifty years of age with venous thrombosis, especially those who have had a non-fatal embolism, have responded less favorably than younger patients to the use of anticoagulants without venous section and ligation.

Heparin, a tissue extract, obstructs the conversion of prothrombin into thrombin. Diluted in normal saline or glucose solution and given slowly by vein it acts almost immediately. Dicumarol, on the other hand, has a delayed action, according to Evans,<sup>1</sup> from one to six days; usually its effect is present in twenty-four to seventy-two hours. The effect of both of these drugs on any patient cannot be accurately predicted, there being a wide variation in effect on different individuals. The effect of heparin is observed by repeated clotting

time determinations taken at three- or four-hour intervals until a fifteen-minute clotting time is reached. Attempt is made to maintain the clotting time at this level until the dicumarol prolongs the prothrombin time.

Heparin administration prolongs the clotting time and the clot retraction. According to Evans it may lower the prothrombin level to 75 per cent of normal. Dicumarol, now synthesized (formerly extracted from spoiled sweet clover), is a poison the exact mode of action of which is unknown. It interferes, however, with the formation of prothrombin, and thus lowers the prothrombin level. Evans states that it prolongs the clotting time only when the prothrombin level is very much reduced (in the vicinity of 40 per cent of normal) and that it has no consistent effect on clot retraction, platelet count, serum calcium or serum fibrinogen.

Dicumarol given by mouth is begun simultaneously with the heparin. Like heparin, its effect on the individual varies tremendously, so that attempts to standardize dosage have failed. Evans recommends an initial dose of 300 mg. for a patient less than 120 pounds and 400 mg. for one above that weight, followed by a daily maintenance dose of 100 to 300 mg. daily. The prothrombin level is reduced to less than 70 per cent of normal; the drug is discontinued if it should fall below 60 per cent of normal. Judgment is necessary in the administration of the daily dose; a rapidly falling prothrombin level necessitates withdrawal of medication or reduction of the dose. A slowly falling prothrombin level requires a larger daily dose.

With venous thrombosis, with or without pulmonary embolism, the dicumarol should be continued for one or two weeks. Evans believes that the patient may sit up as soon as the prothrombin level is below 70 per cent of normal. Of forty of his patients with postoperative venous thrombosis, nine were out of bed within one week and twenty-seven within two weeks. Of forty-six patients with venous

thrombosis treated with dicumarol, with or without heparin, he reports only one benign and no fatal emboli.

There is some evidence<sup>3</sup> that the administration of large doses of vitamin K may reduce the prolonged prothrombin time created by the administration of dicumarol. Whole fresh blood transfusion and the withdrawal of the drug are the most effective measures in reducing the prolonged clotting and prothrombin time induced by either heparin or dicumarol.

Needless to say, anticoagulant drugs are no panacea. They have not supplanted prophylaxis, including specifically postoperative foot dorsiflexion and extension exercises, and avoidance of unnecessarily prolonged restriction in bed. They have not done away with the necessity for constant awareness of the specter of thrombosis in every postoperative or puerperal patient and prompt recognition and institution of treatment.

Barker, Allen, and Waugh<sup>2</sup> list the absolute contraindications to the use of dicumarol as follows: (1) renal insufficiency, (2) purpura of any type, (3) blood dyscrasias with bleeding tendencies, and (4) existing prothrombin deficiencies, as in jaundice, hepatic disease, malnutrition and subacute bacterial endocarditis.

They list the following as relative contraindications: (1) existence of ulcerating lesions, open wounds, or potentially bleeding surfaces, (2) necessity for surgical operation during the next two weeks, and (3) continuous gastric drainage.

The reasons for these contraindications are clear when they report forty-seven cases of bleeding, eighteen of them (4 per cent) serious, in a series of 497 postoperative cases treated with dicumarol. Evans reports two deaths (4 per cent) and eight cases of hemorrhage (14 per cent) out of fifty-six patients treated with dicumarol at The Lahey Clinic. The great variation of individual tolerance to heparin and dicumarol make their administration difficult and may result in hemorrhage as in our case. This need not be wound hemor-

rhage. There may be cerebral hemorrhage, pulmonary hemorrhage from the region of the infarct, or urinary tract bleeding; indeed, bleeding may occur almost anywhere. Small initial doses and close observation are recommended when these drugs are used. The short duration of the effects of heparin, as contrasted to the delayed and prolonged effects of dicumarol, makes it the safer drug even though it is more difficult to administer and is more expensive. Prolonged, slow intravenous drip of dilute heparin solution is probably safer therapy than the combined use of both heparin and dicumarol.

#### SURGICAL INTERVENTION

Proximal venous ligation is by no means obsolete, not only in patients over fifty years of age with venous thrombosis and a warning non-fatal embolism, but also in some younger patients. Our patient had a large loosely attached clot in the iliac vein which if cast free might well have caused an initial fatal embolism without warning. Awareness that thrombophlebitis and phlebothrombosis are often associated is necessary in the proper evaluation of the patient and the proposed therapy.

Prompt femoral vein ligation in the presence of a deep venous thrombosis of the leg interposes a block to proximal propagation of that thrombus and to any emboli that may be released. If the ligation can be carried out at the junction of a large patent vein, such as the profunda femoris, no stagnant venous pool is left proximal to the ligature. This is a worthwhile precaution, if possible, for propagating thrombi proximal to the region of ligation have been reported. For this reason Evans has recommended the use of anticoagulant therapy following femoral ligation. We do not hold this usually necessary, especially as there is a high incidence of hemorrhage from the use of anticoagulants; apparently ligation of the femoral vein proximal to the thrombosis is rarely followed by pulmonary emboli. In the case presented anticoagulants were used because of the

extension of the thrombus to the bifurcation of the vena cava and the risk of thrombotic extension to the contralateral iliac vein. Their use was promptly discontinued because of the above stated bleeding tendency, especially since the prothrombin level fell so low before the dicumarol could have had effect. Vitamin K was used in this case only on an empirical basis because the prothrombin time was markedly prolonged by the heparin before dicumarol could have had effect. The recovery was almost certainly due to prompt transfusion rather than the vitamin K.

Swelling of the thigh, however slight, suggests extension of the thrombus proximal to the inguinal ligament. Inasmuch as there was no abdominal or rectal tenderness and there was only moderate preoperative swelling of the thigh, initial exploration of the femoral vein in Scarpa's triangle was justified, as a loose thrombus extending only a short way proximal to this point can sometimes be sucked back, thus making abdominal surgery unnecessary.

Paravertebral sympathetic block with procaine, or by surgical interference as in the case presented, helps reduce the edema of the extremity. Interruption of the sympathetic pathways blocks vasoconstrictor impulses and thus allows better collateral circulation with resultant diminishing edema. It was noted that in this case the affected leg was warm and pink and at no time showed any effect from the venous ligation. It was believed that the sympathectomy contributed materially to the patient's recovery.

Finally, the dangers of heparin and dicumarol alone or with surgery must be considered and weighed against the dangers of surgery alone in each individual case.

#### SUMMARY

1. A case of postoperative iliac venous thrombosis, treated with anticoagulants and surgery, is presented.

2. Both anticoagulants and surgery are useful in the prevention of fatal pulmonary emboli.

3. Sympathectomy in this case seemed to be of striking benefit. Sympathectomy or paravertebral lumbar sympathetic block with procaine might prove of value in every case. The sympathetics are in most cases readily accessible when large pelvic veins are operated upon and their removal should not increase the operative risk unduly.

4. Administration of heparin and dicumarol is potentially dangerous.

5. Prevention is the best therapy.

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ANEURYSMS vary in size from that of a millet seed to a child's head. They may be single or multiple. In order of frequency they involve the thoracic aorta, popliteal artery, femoral artery, abdominal aorta, subclavian artery, innominate artery, axillary artery, iliac artery and the cerebral and pulmonary arteries.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# EXCISION OF THE ELBOW FOR MULTIPLE COMPOUND COMMUNUTED FRACTURES\*

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THE literature on this subject is scanty. Advocating excision of the elbow rather than an arthroplasty later may seem too radical. Certainly arthroplasty cannot be performed with hope of good results in all cases of stiff elbows. There must be indications for excisions in those cases involving severe trauma. Many English writers wrote extensively on its value as an immediate treatment accompanying débridement of gunshot wounds destroying the elbow joint.\* They advised that if it be done early, infection and sepsis are prevented. They agreed that the triceps tendon and fascia should be kept intact and continuous with the periosteum and fascia overlying the ulna.

The length of the convalescent period is shortened, particularly valuable in patients who are dependent upon the use of their hands to earn a livelihood. The lateral instability is obviously not so important in a non-weight bearing joint, such as the elbow. It may be a crude surgical procedure but if the patient is satisfied, and can freely use the part in his work without pain or minimal discomfort, it is not an operation to be thrown into discard. A patient would seem to be better off than with a stiff elbow.

Buzby<sup>1</sup> reports satisfactory results in thirteen out of fifteen elbow joint excisions. One case was for an extensive compound comminuted fracture of the three bones. Nine were for post-traumatic ankylosis, all old healed compound com-

minuted fractures. Pain was almost a negligible factor from the time of the operation, and disappeared when motion began. Extension against gravity is the last function to recover, and lateral instability improved when the patient learned to hold the biceps moderately tight. All the patients reported earn their livelihood by hard physical labor.

Buchanan<sup>2</sup> says, "In this operation the joint ends of all bones are widely removed. Success here, in distinction to other joint operations, depends upon the wide removal of bone. There should be three finger's breadth between the arm and forearm bones in the extended position when placed in a moderate stretch."

Campbell<sup>3</sup> states that excision of the elbow is indicated when destruction is severe, but has reference to infection, and does not mention compound fractures. This procedure is not indicated in children.

Churchill<sup>4</sup> says in a few cases in which serious trauma or early established infection has irreparably ruined the joint architecture, resection of the joint has been performed and satisfactory healing in a position of maximum usefulness achieved. This obviously means that an arthrodesis results rather than a pseudoarthrosis. No doubt there will be more abundant literature on this subject from the surgical divisions of the military departments in the future.

Christopher<sup>5</sup> interestingly states that fractures of the lower end of the humerus, and upper end of the radius and ulna constitute one-tenth of all the fractures in the body, but no mention is made of elbow

\* A. E. Moore, W. M. Shepar, C. M. Moullin, R. H. J. Swan, C. H. Fogge in the *Brit. M. J.*, in 1917-1918.

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joint excision for severely comminuted compound fractures. Key and Connell<sup>6</sup> concur in this opinion.

in spite of instability and minimal pain. Their cases presented relatively the same indication; viz, severely compounded com-



FIG. 1. X-ray film showing marked comminution involving fractures of the lower end of the humerus, and upper ends of the radius and ulna. Note the marked distortion of fragments, and absence of joint continuity.

Jones and Lovett<sup>7</sup> state: "It is an open question whether arthroplasty has sufficient advantage over excision to warrant one in pronouncing it the operation of election." This is a conservative evaluation.

Kini<sup>8</sup> advises that the bone ends should be kept apart in elbow excisions with the use of skeletal traction, followed by a short period of plaster of Paris fixation, and physiotherapy measures later. The power of flexion should be against resistance. Evaluation is based upon (1) the cosmetic result, (2) weight lifting (10 pounds), first with the affected arm hanging by the side, and secondly with the arm abducted and the forearm in full extension.

Levit<sup>9</sup> emphasizes that the best treatment for gunshot wounds of the elbow joint, complicated by fractures, is early resection with early therapeutic exercises.

McLaughlin and Smith<sup>10</sup> have done several cases with reasonably good results

minuted fractures of the elbow involving the humerus, radius, and ulna.

Murray's<sup>11</sup> comments are most informative. Most of the cases presented in the literature were the result of gunshot wounds. He is impressed by the comparative rarity of flail elbows reported in the literature. Differentiation of those cases in which there is loss of bone forming the joint with good practical muscle and nerve control, from those in which there is loss of bone with loss of practical muscle and nerve control, must be made. The former are classified as active flail elbows. The findings in this case report indicate the former classification. Murray recommends restoration of the normal shape and size of the bone ends affording better contact for resistive pressure. A good pad of fibrous tissue that will obviously form between the bone fragments ought to substitute reasonably well however, in the writer's opinion.

Scudder<sup>12</sup> says, "Fractures of the lower end of the humerus entering the elbow joint are generally recognized as giving relatively poor functional results. Treatment of an adult elbow joint fracture should be very carefully thought out from the date of the injury. Partial excision of the elbow has been followed by satisfactory results in a few cases in which it has been used."

Shorbe<sup>13</sup> in a very interesting review of severe elbow injuries associated with automobile door etiology, i.e., driving with the arm resting on the car door sash and protruding, states that in extensive comminution of the lower end of the humerus early removal is the best form of treatment. Results are surprisingly good in spite of instability and some weakness. The results in his series were uniformly bad in the severe cases with the use of skeletal traction in selected forms and occasionally open reduction with fracture assembly. It would seem that with such poor results using the usual accepted fracture management, elbow joint excision, particularly if an active flail elbow may be obtained, should enter the plan of treatment more often. This obviously refers to the severely comminuted compounded fractures. The argument may be advanced that even should ankylosis occur, arthroplasty may be done later.

Speed<sup>14</sup> states that in the severely compound comminuted fractures, complicated by infection, ankylosis is to be expected. Reconstruction measures are advocated at a later date.

West<sup>15</sup> says in supracondylar fractures of the humerus of the worst type with practically no movement as an end result, an excision may be considered if the patient is willing to sacrifice stability for movement. It has been the writer's experience in this type of case to observe many cases of ankylosis.

The following case report is submitted; suggesting consideration of this procedure in selected cases.

#### CASE REPORT

A white male, fifty-five, janitor, was admitted to Hurley Hospital, Flint, Michigan



FIG. 2. Postoperative x-ray film showing complete elbow joint excision.

on August 30, 1944, at 10:30 A.M., about one-half hour after falling from a height of two stories and sustaining injuries involving the right shoulder and elbow. There were no associated injuries and his general condition was good.

Clinical examination of the right shoulder revealed nothing significant. There was some ecchymosis with generalized edema and tenderness. X-ray examination later showed a fracture in the mid-scapular area without displacement. The right elbow, however, showed a large, deep, jagged gaping transverse wound about three inches in length, on the posterior aspect about the level of the humeral condyles. There was moderate bleeding, and the wound was contaminated with dirt. The slightest movement was painful. Deformity was present, but there were no evidences of associated radial or ulnar nerve involvement. X-ray examination showed "comminuted fractures of all bones of the elbow joint."

The patient was a good surgical risk and was accepted for immediate exploratory operation.



The original wound was of adequate size for this purpose. Meticulous local preparation was done, viz, shaving, thorough scrubbing with

and radial bone ends were sawed off, leaving the clean smooth stumps. The biceps tendon attachment was preserved. The wound was



FIG. 3. Progress x-ray film, eight months postoperatively. There is some osteophyte production and spur formation present, with ample space between the bone ends.

green soap, and copious saline irrigation. Identification of structures was attempted. The radial and ulnar nerves were not seen. The triceps tendon was completely detached with the olecranon fragmentation. The comminution was marked and there were many bone fragments of all sizes and shapes in distorted positions. The humeral condyles, radial head, olecranon, and a portion of the ulnar shaft were identified in numerous pieces. There was marked devitalization of overlying soft structures, with much dirt deposited in the wound. The biceps tendon was intact at its radial attachment. Assembly of the many bone fragments into some degree of relationship was considered mechanically impossible. The hazard of secondary bone infection and necrosis was great, and at best a fixed elbow in a selected position of optimum use was all that could be expected under the most ideal circumstances. There no doubt would have been persistent sinuses for a long time.

Complete excision of the elbow was selected. The loose bone fragments were first removed. Devitalized soft tissues were excised, hemostasis secured, and the jagged humeral, ulnar,

again thoroughly irrigated with normal saline, the triceps tendon remnant sutured to the posterior deep fascial plane of the forearm, and the wound closed with cotton sutures. About 7 Gm. of sulfanilimide powder were dusted in the wound. The arm was placed at right angles and laid on a pillow, following application of a loose dressing. The whole operative procedure took about one and one-quarter hours.

The patient's reaction was good, and the postoperative course was afebrile after the first two days. Five Gm. of sulfathiazole were given orally in divided doses every twenty-four hours for the first six days. Pain was minimal. The wound healed by first intention, and physiotherapy was started on the tenth postoperative day, directed toward active and passive movements principally. The patient was ambulatory on the twelfth day, with the right arm in a sling. He was discharged from the hospital on the nineteenth postoperative day, September 18, 1944, with no significant complaints. There was beginning active forearm flexion and one could see the biceps muscle in play. Triceps function was minimal.

Close observation was given this case, and

FIG. 4.

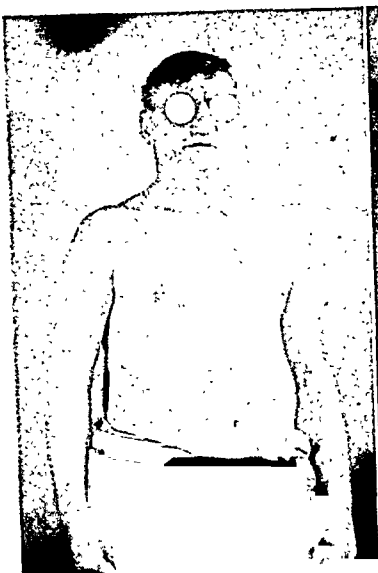


FIG. 5.



FIG. 6.



FIG. 7.



FIG. 4. The patient, eight months postoperatively, with the right upper extremity hanging at his side, in complete extension, with the forearm in pronation.

FIG. 5. Right forearm at right angles midway between supination and pronation. Note the contour of the contracted biceps muscle.

FIG. 6. Right forearm in almost complete flexion, with the arm hugging the lateral chest wall.

FIG. 7. Right arm abducted 35 degrees, with forearm in pronation. Note absence of visible deformity at right elbow. Both upper extremities are relatively the same size.

careful but constant physiotherapy measures were carried out postoperatively for months. The patient returned to light duty on the



FIG. 8. Right arm in 75 degrees abduction, with forearm in complete flexion, and in mid-supination and pronation. Note healed transverse scar on the posterior aspect of the elbow.

fortieth postoperative day, and at present, is conducting the major portion of his pre-trauma work. There is no pain. The elbow is flail and unstable but very useful. Flexion is complete. There is minimal triceps function. Grip is good in the right hand and the patient is able to lift about ten to fifteen pounds. The convalescence was definitely shortened. The accompanying x-ray films and photographs are self explanatory. (Figs. 1 to 8.)

## SUMMARY

A case report is presented describing the care of a severe, compound, comminuted fracture of the right elbow by complete joint resection. The satisfactory result obtained would give the impression that this procedure has merit in such cases and should receive consideration in the plan of management.

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# TRAUMATIC BRAIN ABSCESS AND MENINGITIS\*

## CURE EFFECTED WITH PENICILLIN AND SULFADIAZINE

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IF one reviews the surgical treatment of brain abscess, such a wide divergence of opinion will be found that we may readily conclude that the accepted treatment is still to be determined. Peculiarly enough the pyogenic organisms primarily responsible for brain abscess are controlled by the sulfonamides and penicillin. The organisms most frequently encountered in brain abscess are: *Streptococcus pyogenes*, *Staphylococcus pyogenes aureus*, pneumococci, hemolytic streptococci, occasionally colon bacilli and gas forming spore-bearing anaerobes, and *Bacillus typhosus*. In view of the questionable results obtained in the treatment of these abscesses it was considered of interest to report the case of brain abscess associated with meningitis in which we are certain the patient would have succumbed had not surgery been combined with the use of sulfonamide and penicillin.

Infections may enter the brain through four separate pathways; (1) by direct extension along the blood vessels, Virchow-Robin spaces, preformed pathways, nerve sheaths, or foramina; (2) by direct implantation from penetrating wounds; (3) by means of infected emboli carried through the blood stream, and (4) by unknown pathways.

The most frequent cause of brain abscess is otitis media and mastoiditis. In Evans' group of 194 cases, 56.8 per cent arose from this area, whereas in a series of Courville and Nielsen 46 per cent had a similar origin. Suppuration in the nasal cavity and accessory sinuses was the cause in 6.3 per cent of Evans' group;

invasion of the brain by malignant growth in 1 per cent, and metastatic suppuration in 23.7 per cent. Approximately one-half of the metastatic group arose from either chronic bronchiectasis or empyema, and the other half from extrathoracic suppuration. Metastatic abscesses carry with them a high mortality partly because approximately 50 per cent are multiple.

The frequency of brain abscess fortunately is small. In a series of 94,469 cases, Dench discovered eleven patients with brain abscess. Courville and Nielsen in reviewing the statistics of the continental clinics, found 0.19 per cent, 277 instances with brain abscess in a total of 147,604 cases. The frequency of brain abscess occurring in otitis media also is extremely small. Evans reporting on 10,280 autopsies from the London Hospital found 718 cases of otitis media, with seventy-four, or 10.3 per cent with brain abscess. In 45,272 autopsies sixty-eight, or 0.15 per cent revealed brain abscess.

Brain abscess also rarely follows head injury unless the dura is penetrated. Holmes in a series of 2,357 post-war head injuries found twenty-seven cases of abscess, or 1.4 per cent. They occurred only when the dura had been opened. Tuffier and Gualian in a series of 5,644 post-war head injuries found ninety-four, or 1.4 per cent with abscess.

Macewen, in 1893, reported on a series of twenty-five cases of abscess, six patients of whom were moribund and died without operation. The other nineteen were operated upon and eighteen recovered. He evacuated the abscesses completely, re-

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peatedly washed out the cavities with antiseptic solution and rarely used a drain. In the cases in which the capsule was old and thick and failed to collapse, he used such drains as decalcified chicken bone which later became absorbed, or rubber or glass. These spectacular results of Macewen were due to a combination of the drainage method later advocated by Elskey and Coleman, the tapping method of Dandy, and the unroofing technic of King.

Objections were found to the use of rubber tubes because they often collapsed and to glass tubes because they became dislodged, penetrated the brain substance and spread the suppuration. All types of tubes were found to be forced out from the brain and the dressings were difficult and dangerous. For this reason they were replaced by gauze drains, but as the gauze became moistened with pus, it acted as a plug, thus naturally defeating its purpose. Cigarette drains were also tried, but without success. However, folded layers of guttapercha were an added improvement. Success was obtained by the use of the wire gauze drain of Mosher. The improvement in rubber tubing led to the reintroduction of the rubber drain by Coleman. Later, the unroofing method was suggested by King.

The modern surgical treatment of brain abscess may be divided into three groups: (1) closed method with drainage or tapping; (2) open method and (3) extirpation.

*Closed Method.* If the indication for immediate puncture is not too urgent, the wound should be packed with gauze soaked in a mild antiseptic solution, and the dura, arachnoid and pia about the opening should be coagulated with the electrosurgical unit. The incision should then be closed, and reopened within twenty-four to forty-eight hours. When the needle is introduced into the abscess and the smear does not reveal any bacteria, one or two aspirations may be sufficient to clear the abscess. This method was later suggested by Dandy. Successful cases have been reported

by Grant, Puusep, Spasokukotsky, Patrikios and Sbarounis, Vincent et al. If the pus, on the other hand, contains many organisms, a rubber drain is placed through the opening and into the abscess. A special needle described by Grant is of value in inserting the tube. The rubber tube is sutured to the galea and the wound closed around the tube. The tube is left *in situ* for a week, then the suture is cut and the tube is allowed to extrude itself in the course of two to three weeks. Worms and Ferey have suggested repeated aspirations of pus through the tube. Coleman reports twenty-six cases with twenty-one recoveries and Grant reports twenty recoveries in thirty cases.

*Open Method.* Once the capsule of the abscess has been identified by the exploring cannula, the opening is enlarged in the skull. The dura is opened in a stellate fashion and the subarachnoid space is sealed off by packing gauze soaked in  $\frac{1}{4}$  strength of iodine between the dura and the arachnoid for twenty-four hours (Bucy), or suturing the dura to the cortex with fine catgut (King and Adson), or by coagulating the dura, arachnoid and pia to the cortex with the electrosurgical unit (Cahill and Horrax). The cortex is now either incised, (Adson and McKenzie) down to the abscess wall, or excised and removed with the electrocautery or suction (Bucy, Kahn, King, Toby, Bagley), until the surface of the capsule is exposed. The surrounding brain is held back by general retraction, the pus is evacuated through the exploratory needle, the abscess cavity is opened and the remaining material is sucked out under direct vision. The abscess cavity is then packed and kept open with gauze, or a soft rubber tube is inserted in the cavity without gauze (McKenzie); the cavity may be filled with long strips of rubber tissue (Robinson); or iodoform gauze be packed about two soft rubber catheters (Adson, Bucy); iodoform gauze alone may be used (King); a conical wire mesh basket has been suggested as a drain (Mosher). Horrax evacuates the pus

and sutures the capsule to the galea or pericranium, thus marsupializing the abscess. Kahn identifies the abscess cavity and introduces thorotrast into the cavity after removal of pus. The abscess then slowly progresses outward toward the surface of the brain. As a rule, however, the cortex herniates through the operative wound as the abscess migrates toward the surface. The protruding brain is removed by suction, the abscess cavity being opened, evacuated, marsupialized, packed and drained.

On one occasion the authors permitted the brain to herniate out through the opening and the entire abscess capsule extruded with the herniation, so that we were able to resect the abscess away from the surface of the brain.

In all of these variations of the open method, removal of the pack begins after one week and is completed between the tenth and twelfth days.

*Extirpation.* Vincent was the first deliberately to remove an encapsulated post-traumatic abscess. In case the abscess membrane was thin, and would not permit enucleation, Vincent performed repeated drainage with decompression so as to permit a thickening of the abscess wall. Enucleated abscesses have been removed successfully by Vincent, Morton, Dott, Cairns, and Adson.

#### CASE REPORT

On November 21, 1943, H. H. a male, aged sixteen, was in an automobile accident, entering the Permanente Hospital unconscious and in deep shock. Hemorrhage from the nose and mouth and a subconjunctival hematoma of the right eye were found. Spinal fluid as well as blood was draining from the nose. Physical examination the following day after the patient regained consciousness revealed a well developed male lying quietly in bed. There was an area of contusion over the left frontal region and marked tenderness over the left orbit. Temperature was 97.2°F., pulse 92, respirations 22, blood pressure 130/60. Corners of the mouth were well and equally elevated; there was no evidence of facial nerve injury.

Pupils were equal and reacted to light and accommodation. Extra-ocular muscles were normal. Vision was roughly normal with normal fundi and sharp disc edges. The left drum was retracted. However, there was no bleeding. There was a loss of the sense of smell. There was a clear fluid dripping from the nose whenever the patient would roll from side to side. The pharynx was clean, the neck glands palpable but not tender and the trachea was in the midline, the thyroid was not enlarged, the lungs were clear and the heart was not enlarged nor were there any murmurs or irregularities. Examination of the abdomen was negative for injury. Abdominal reflexes were normal. No evidence of back injury was noted, there was no tenderness to kidney percussion and the genitalia were normal. No hernia existed in either groin, the cremasteric reflexes were normal, the extremities revealed no evidence of injury; the reflexes and sensation were normal and equal.

X-rays taken on November 21, 1943, revealed a fracture involving the frontal sinus and base of nose on the left, and a slight depression of the superior rim of the left orbit. This fracture involved both tables of the skull with slight depression of the inner table. There was also a fracture involving the petrous portion of the temporal bone on the left which extended forward.

Urinalysis on November 22, 1943, revealed a clear yellow specimen. Reaction 5.0; specific gravity 1.028; pus 2-3; few epithelial cells; few mucous threads; and a few clumps of pus cells. It was negative for albumin, acetone, or red cells. Blood count on November 22, 1943, revealed a hemoglobin of 85 per cent; red blood cells 4,490,000 and white cells 9,000.

The patient remained flat in bed for one month. The leakage of cerebrospinal fluid from his nose stopped within the first week. During the remainder of the time, the patient suffered no unusual symptoms. Temperature, pulse, respirations and blood pressure all remained constant. The patient was dismissed from the hospital to bed rest at home on December 23, 1943. On January 4, 1944, he was allowed to sit up at home. On January 19, 1944, he was seen in the clinic. The fluid was dripping from his nose rather profusely. The fluid would stop dripping when the patient remained flat on his back. Hospitalization was strongly advised; however, the parents would

not consent to this. The patient was placed at bed rest at home. He remained in bed until March 15, 1944, at which time he was allowed to remain out of bed for short periods of time. The rhinorrhea did not reoccur.

On April 8, 1944, the patient was readmitted to the hospital because of nausea, vomiting and headaches. On physical examination at this time, there was found to be a slight stiffness of the muscles of the neck. The eye grounds showed marked papilledema bilaterally of approximately four diopters. Sense of smell was absent in both nostrils. His temperature was 99.6°F., pulse 76, respirations 18. There was a paralysis of the sixth nerve of the right eye with an inability to move the right eye laterally beyond the midline. Other ocular muscles were intact and normally active. The right pupil was larger than the left; both reacted to light, but very little reaction was noted to accommodation. There was no gross limitation of visual fields. Kernig sign was negative. Spinal puncture on April 10, 1944, revealed a pressure of 440 mm. of water with 7 red blood cells per high power field. Spinal puncture on April 15, 1944, revealed a pressure of over 600 mm. of water with 10 red blood cells per high power field. It was believed that increase in pressure was caused by a space occupying mass on the left side. On April 17, 1944, examination revealed temperature 98°F., pulse 70, respirations 18, blood pressure 120/70, sense of smell absent bilaterally. Diplopia was present and there was a right rectus paralysis. The right pupil was larger than the left; both pupils reacted to light, but there was little reaction to accommodation. There was no gross limitation of the visual fields. Discs showed marked choking bilaterally. Cranial nerves 6, 7, 8, 9, 10, 11, 12 were intact. General sensation was intact. Two point discrimination was negative. Vibratory sense showed no abnormality. Upper abdominal reflexes were hypoactive compared with the lower abdominals, cremasteric bilaterally active, arm reflexes normal. The patellar and Achilles reflexes were more active on the right. There were no pathological reflexes. Urinalysis on April 17th was negative to albumin and acetone. It contained 1.5 pus cells per high power field, abundant amorphous deposits, specific gravity 1.018, negative to sugar and a few triple phosphate crystals. Blood count on April 17th revealed hemoglobin of 93 per cent; leucocytes 8,100, erythrocytes of 4,700,000

and a color index of 0.97. The Kline test was negative.

It was our opinion that we were dealing with either a brain abscess or a subdural hematoma. In view of the slightly increased reflexes on the right and because of the history of rhinorrhea a left-sided frontal lesion was suspected. The entire head was shaved and the patient prepared for bilateral frontal perforator and burr openings, under local anesthesia.

The head was prepared in the usual manner with green soap, sterile water, bichloride and alcohol. Local anesthesia was infiltrated in both frontoparietal areas, about midline between the base and the vertex. A small incision was scratched over both of these areas and the field was then draped. With the assistants making digital compression to control the bleeding, an incision was first made on the left side. Hemostats were applied to the galea and a self-retaining retractor was inserted. With the periosteal elevator the scalp was separated from the calvarium. A perforator and burr opening was made through the skull; the dura was tense, but there was no evidence of hemorrhage. The dura was then opened and the brain found to be under considerable pressure; there was no evidence of a subdural hemorrhage. The wound was packed with cotton gauze, and a similar procedure carried out on the opposite side.

In view of the possibility of a left-sided abscess, a brain cannula was first inserted into the right cerebral hemisphere to rule out the question of deep-seated brain hemorrhage, or multiple abscess. Nothing was found on the right side. The wound on the right was then completely closed with silk sutures and a silver-foil dressing applied. An exploratory cannula was then inserted into the left frontal lobe and at a distance of 6 cm. a soft area was encountered which immediately drained thick, greenish yellow pus. A stilette was introduced into the cannula which was then replaced by the brain abscess guide of Grant. Through this guide a small rubber catheter was introduced. We were able to evacuate 75 cc. of thick pus. The abscess cavity was then washed with saline. A smear was obtained and the laboratory reported the probability of a pneumococcal organism. Culture later proved this to be pneumococcus, type III. Penicillin, 25,000 units, was dissolved in 10 cc. of water and this solution was directly instilled into the abscess.

The abscess cavity had contracted, so that it was possible to instill only 8 cc. of the penicillin solution. The remaining 2 cc. were instilled over the cortex and in the surrounding scalp. The dura was not closed. The rubber tube was sutured to the galea and the wound closed with silkworm gut. A dressing was applied and the drain was clamped shut, to keep the penicillin in the abscess cavity. The patient left the operating room in good condition.

Postoperatively on April 18th the patient's temperature was 100.2°F., pulse 100, respirations 24. When the clamp was released from the drain and the drain opened, approximately 10 cc. of bloody purulent fluid escaped from the abscess cavity. Penicillin, 25,000 units were again placed into the abscess cavity after washing with saline. During the washing the patient complained of pain over the right eye. Pulsation was noted in the fluid in the catheter during irrigation. Smear of the material drained from the wound revealed many red blood cells, few pus cells and a few diplococci. Culture revealed the organisms to be pneumococci, type III. Physical signs were unchanged other than that the stiffness in the neck had increased.

On April 19th, his temperature was 101.2°F., pulse 110; respirations 24; on opening the tube approximately 5 cc. of bloody fluid oozed forth. Smear from this specimen revealed many leucocytes and erythrocytes, but no bacteria were seen. The wound was irrigated with saline. There was some resistance felt after about 5 cc. of saline had been placed in the cavity; 25,000 units of penicillin were placed into the cavity. The suture holding the drain in place was cut, and the entire drain was forced out. Spinal tap revealed 41 leucocytes, 13 erythrocytes per cu. mm. During the afternoon the patient's temperature rose to 102°F., pulse to 120. Sixth nerve paralysis was still present. The patient was placed on sulfadiazine. On April 20th the sulfa level in the blood was 23.5 mg. per cent.

On April 21st, his temperature was 100°F. Cisternal puncture and spinal puncture were done and revealed a pressure of 300 mm. with no block present. His pulse was 100, respirations 22. The cell count from the spinal fluid was 72, and from the cisternal fluid 129 cu. mm.; 25,000 units of penicillin were injected into the spinal canal.

On April 22nd his temperature was 98.9°F.,

pulse 94; respirations 22. Spinal fluid pressure was 480 mm. with a cell count of 54 per cu. mm. Ten cc. of fluid were removed and 25,000 units of penicillin in 4 cc. of fluid was again administered into the spinal canal.

On April 23rd his temperature was 98.6°F., pulse 86, respirations 20, spinal puncture revealed a pressure of over 600 mm. of mercury. This pressure was due to the fact that the patient was not cooperative and was straining. There were 10 erythrocytes per high power field; no white blood cells; 25,000 units of penicillin were again administered into the spinal canal. The sulfa level (blood) was 11.7 mg per cent. The white cell count 9,800, red cell count 4,500,000. The urine was essentially normal and showed no crystals.

On April 27th, his temperature was 98.8°F., pulse 86, respiration 20. Spinal tap showed a pressure of 300 mm. of mercury; 10 cc. of fluid were removed and the pressure dropped to 140. Cell count revealed 10 lymphocytes and 6 polymorphonuclears with 84 red blood cells. The blood sulfa level was 11.5 mg. per cent.

On May 1st, his temperature was 98.6°F., pulse 90, respirations 16. No unusual signs or symptoms had developed. The wound was clean, and sutures were removed. There was still papilledema in both eyes. Sixth nerve paralysis was still present on the right side. There was more strength in the right hand than in the left. Abdominal reflexes were absent.

On May 3rd, his temperature 98.2°F., pulse 98, respirations 20; a spinal puncture revealed a pressure of 280 mm.; 5 cc. of fluid were removed. The cell count revealed 21 red blood cells and 1 white blood cell. The wounds were clean. The sixth nerve paralysis on the right was still present. Weakness of the left hand was still present, however, no other neurological signs were found.

On May 11th, the patient was dismissed from the hospital to be followed in the out-patient clinic. His temperature was 98°F., pulse 84, respirations 20.

On May 25th, the patient was examined in the out-patient clinic and found to be in good physical condition. The wounds were clean. The right eye now moved readily to the mid-line only. Knee jerks were slightly hyperactive but equal. Eye discs were still choked. The sense of smell was still absent.

On June 27th, the patient had been up walk-



ing around without difficulty. Pupils were equal and regular, reacted to light well and the discs showed no papilledema. There was partial lateral right rectus palsy, and the patient was attending school.

On July 26th, the right eye moved to almost complete range of normal motion. He had no neurological symptoms, no complaints or signs of recurrence of brain abscess, and had been working for almost two months.

On December 15, 1944, the patient had no complaints and was working actively. Ex-

amination revealed him to be completely normal.

#### SUMMARY

This patient with brain abscess was cured by three direct instillations of penicillin into the abscess cavity for a total of 75,000 units, and the resulting meningitis arising therefrom was treated by an additional 75,000 units of penicillin injected into the spinal canal, plus the use of sulfadiazine.



OSTEOMYELITIS of the skull may be the result of trauma, hematogenous infection, direct extension from infections of the nasal sinuses or mastoid, syphilis, or tuberculosis. It may be localized or spreading. The common infecting organism is *Staphylococcus aureus*.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# THROMBOSIS OF THE BRACHIAL ARTERY TREATED WITH SUCCESSIVE CERVICAL SYMPATHETIC BLOCKS

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SYMPATHETIC chain block is now recognized as a valuable procedure in the management of several different clinical conditions. These conditions include thrombophlebitis, causalgia, certain severe chest injuries, and occlusive arterial lesions of both sudden and gradual onset.<sup>1-6</sup> Viability of an extremity may be threatened by the sudden occlusion of a major artery and it is in such cases that this method of treatment may yield most spectacular results by producing sufficient vasodilatation in collateral channels to overcome the critical circulatory deficit.

Traumatic arterial injuries may result in perforation of the vessel, thrombosis of a vessel without perforation or in a severe spasm of the arterial wall which at times is sufficient to shut off the flow of blood through the vessel.<sup>7</sup> Also, in some cases in which there is a perforating wound or thrombosis of a main vessel; the collateral vessels may undergo a spastic contraction which further diminishes the circulation to the part distal to the lesion. The case reported below is not especially unique, however, it is an excellent example of the striking benefit that in some cases may be derived from repeated sympathetic blocks.

## CASE REPORT

The patient, a well developed twenty-nine year old soldier, was admitted to the hospital at 3 P.M. September 2, 1944, one hour after being in a truck accident.

The history revealed that the patient was riding in a truck when it ran off an embankment 45 feet high. The patient was thrown to the ground, and his right arm at a point 2½ inches below the axilla was pinned to the ground by the gate of the truck body. Thirty minutes elapsed before the truck gate was removed, thereby releasing the patient. The

patient experienced pain at the site of the contusion of the right arm and right lateral chest wall and also experienced pain in the left shoulder. On admission to the hospital his general condition was fair, the patient was conscious and there was no evidence of severe shock. Examination in the receiving office revealed the presence of a simple fracture of the left clavicle and contusions of the right chest wall, right arm and right side of the face. No radial pulse could be felt on the right. A normal brachial pulse could be felt in the right arm above the site of the contusion where the truck gate had compressed the arm for thirty minutes. Sensation as tested by cotton and pin prick was greatly impaired. Movement of the fingers and thumb were almost absent and there was some weakness of the extensors of the right wrist. The right hand was definitely cooler than the left and was moist. Slight cyanosis was present. There was no evidence of a large hematoma, pulsating, or otherwise, in the arm although a definite contusion with ecchymoses was present. The impression at this time was that the patient had a severe spasm of the right brachial artery.

At 6:20 P.M. a right cervical sympathetic block was performed with 2 per cent procaine. Following this, the arm felt slightly warmer, however, the results were not conclusive.

Precautions were taken to see that no form of heat was applied to the right arm. Heat in the form of hot water bottles was applied to the trunk and to the lower extremities in an effort to produce reflex vasodilation.

At 9:30 P.M. aminophyllin was given intravenously and another cervical sympathetic block was done. Papaverine, which might have been given, was not available. Thirty minutes after the second sympathetic block, the right arm and hand were dry and definitely warmer than previously, however, the right side was still cooler than the left and the pulse still could not be felt at the wrist. Sensation appeared to be better but was definite by not normal. Two and one-half hours after the block,

the forearm and hand had again become cold, therefore at midnight a third block was done. The effects of this block likewise persisted for only two and one-half hours and the procedure was repeated at 3 A.M. and again at 6 A.M. Following the sympathetic ganglion procaine injection, performed at 6 A.M. September 3, 1944, the hand remained warmer than at the time of admission. Sensation from this time on remained much better than during the first few hours following admission. At 9 A.M. the hand was still fairly warm. The hand did not become cold again, however, another block was performed at 11 A.M. and again the following day.

A very weak but definite radial pulse at the right wrist was found by various observers seventy-two hours following the injury. This pulse could be felt at times for a period of three days, after which it could no longer be demonstrated. Sensation returned to normal, however, the patient was unable to use the intrinsic muscles of the hands more than 50 per cent of normal and there was some weakness of the forearm. Wrist drop was not present. The patient was kept in bed for one week after which time the left shoulder was immobilized with a bandage and physiotherapy in the form of active and passive exercise for the right hand was begun.

On September 15, 1944, because it was felt that a long period of time would be required before recovery from the contused ulnar and median nerve would take place, the patient was transferred to a general hospital. September 30, 1944, the patient was seen again. His general condition was about the same, the radial pulse on the right was absent. A brachial pulse above the point of contusion was present.

It is now believed that this case is one of thrombosis of the right brachial artery with an associated contusion of the right median and ulnar nerves. At the time of admission the circulation of the right arm appeared to be definitely deficient. Important points in treatment were frequent sympathetic blocks and the avoidance of heat to the arm. The patient was also prevented from smoking during this period.

It is interesting that the effects of the earlier sympathetic blocks lasted only two and one-half hours, while at a later time when the balance of circulation had been restored the effect was more prolonged. This emphasizes

the importance of performing blocks as frequently as is shown to be necessary by examination, instead of on an empirical basis of two to four times a day. Alcohol injections would of course produce a more lasting effect. Since alcohol, however, is more likely to be associated with unfortunate complications than procaine, such as a severe neuritis, the author has preferred to rely upon the repeated use of procaine or upon sympathectomy produced by surgery, rather than upon the injection of alcohol. The fact that the radial pulse failed to return speaks for thrombosis rather than spasm of the artery.

*Comment.* The management of injuries of the large arteries is a problem of paramount importance in both civil and military practice. In some cases in which a major artery has been partially severed, the most widely practiced procedure is ligation of the artery after complete division, accompanied by ligation of the concomitant vein. Following this, all possible methods are used to secure the maximum amount of dilatation of the collateral channels. This is usually accomplished by successive procaine sympathetic chain blocks, or by this procedure followed by sympathectomy. Sympathectomy in the lumbar region has usually been associated more consistently with satisfactory results, than have operations of this nature performed in the cervical region.<sup>8</sup> This is apparently due to the fact that the lumbar region operation interrupts the pre-ganglionic fibers, whereas in the cervical region the post-ganglionic fibers are the ones interrupted.

The method of re-establishing the continuity of a severed artery as described by Blakemore, has recently received favorable comment.<sup>9,11</sup> Blakemore described a non-suture method of arterial anastomosis, in which a vein graft which bridges the defect is held in place by small vitallium tubes. This contribution will undoubtedly play an important part in saving some extremities from gangrene, however, the war cases to which the method is applicable are limited. Also, as with any method the

results are not always satisfactory, as thrombosis or blow out may later occur at the site of the anastomosis.

A procedure recommended in a number of standard books for the treatment of severe arterial spasm, with interruption of blood flow is resection of a portion of the artery. This is based on the assumption that the sympathetics will be interrupted distal to the division of the artery and, that this also may cause the release of some of the vasospasm in collateral channels. This procedure does not appear to be entirely rational when a sympathetic block can be more easily performed and if successfully done removes far more of the vasoconstrictor impulses affecting an extremity than would be accomplished by merely dividing the artery. Similarly sympathectomy may be performed in certain cases giving a constant and prolonged interruption of the vasoconstrictor fibers.

The deleterious effect which may be produced by applying heat to an extremity suffering from a deficient blood supply is now widely appreciated. Several years ago Norman Freeman pointed out that heating a part speeds up metabolic processes thereby making the demand for oxygen greater, and in cases in which it is impossible for this oxygen lack to be compensated by an increased blood flow tissue necrosis is more likely to occur. This point has been repeatedly emphasized by writers dealing with this subject. It is well known that external heat applied to other parts of the body such as the trunk and uninvolved extremities, may result in reflex vasodilatation all over the body and as such, this is a rational form of therapy.

In the author's experience, vasodilator drugs have not been of great benefit in such cases, however, papaverine given in rather large doses has often been recommended.

#### SUMMARY AND CONCLUSIONS

1. A case of thrombosis of the brachial artery, treated by frequently repeated cervical sympathetic blocks is presented.
2. Procaine sympathetic block is a well established form of therapy in the management of injuries to major arteries.
3. The importance of repeating such blocks as often as is necessary, to maintain adequate collateral circulation is emphasized.
4. Some of the important principles in the management of injuries of the larger arteries are discussed.

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# DIVERTICULITIS OF THE VERMIFORM APPENDIX\*

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**D**IVERTICULOSIS of the vermiform appendix is exceedingly rare and diverticulitis is even more infre-

quent. There had been no remarkable loss of weight, dysuria or respiratory complaint.

Three months before she had had a spon-

FIG. 1.



FIG. 2.

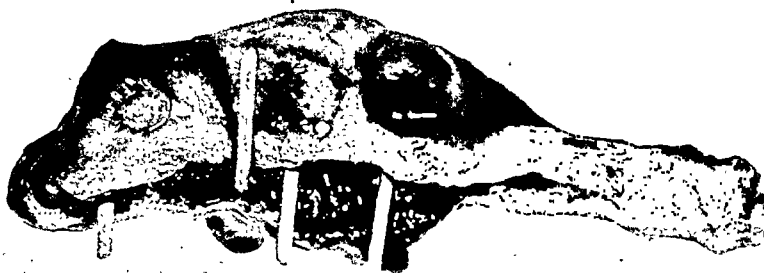


FIG. 1. Showing the appearance of the appendix and diverticula immediately after operation.

FIG. 2. Showing the communications of the diverticula with the lumen of appendix.

quent. A case of appendiceal diverticulosis with superimposed subacute inflammation has been observed recently and is recorded here as a clinical oddity.

## CASE REPORT

M. A., a white female, aged twenty-two, was first seen on August 20, 1943, complaining of recurrent attacks of colicky right lower quadrant abdominal pain of ten days' duration. The pain was associated with nausea and constipation but not with vomiting, anorexia or

taneous miscarriage and her convalescence was uneventful.

Physical examination revealed a well developed and well nourished white adult female who did not appear ill. The temperature was 98.6°F., pulse rate 84, and respiratory rate 22. The head, neck, heart and lungs were essentially normal and the blood pressure was 118/82. The significant physical findings were limited to the abdomen where a moderate amount of tenderness to deep palpation was present. The tenderness was not sharply

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localized and was not associated with muscle spasm nor rebound tenderness. The pelvic examination was not remarkable.

Because she continued to complain of the colicky abdominal pain during the following three weeks under this therapy, she was ad-



FIG. 3.



FIG. 4.

FIG. 3. Showing the continuation of layers of appendix over its diverticulum.  
FIG. 4. The subacute inflammatory reaction of the mucosa, submucosa and muscularis is illustrated.

The white blood cell count was 6,800 per cc. with 72 per cent polymorphonuclears. The red blood cell count was 3,980,000 and the hemoglobin 80 per cent. The urinalysis and Kahn tests were negative.

A tentative diagnosis of subacute mesenteric lymphadenitis was made and the patient was permitted to return home under observation and conservative treatment consisting of rest, bland diet, and the administration of mineral oil, 1 ounce twice a day was ordered.

mitted to the hospital on September 14, 1943, for observation and appendectomy. Operation was performed through a McBurney incision and a rather large appendix was found. Multiple large sacculations were evident on the surface of the appendix and in its mesentery. (Fig. 1.) These were diverticula, two of which showed gross evidence of inflammation. Appendectomy was performed in the usual manner and the ligated stump was inverted by means of a purse-string suture of fine black silk. The

wall of the terminal ileum was normal and several enlarged lymph nodes were found in its mesentery. There was no Meckel's diverticulum or visible diverticula of the cecum and transverse colon. The wound was then closed in layers without drainage and the patient was returned to her room in good condition.

The postoperative course was uneventful and the operative wound healed per primam. On September 23rd she was discharged from the hospital without complaint.

The specimen consisted of the appendix and its attached mesentery. Multiple diverticula involved the wall of the appendix and mesentery, and two of these were edematous, red, and obviously inflamed. Longitudinal section demonstrated that the lumen of the diverticula communicated freely with that of the appendix. (Fig. 2.)

Microscopic examination showed that all layers of the appendiceal wall were continued over the diverticula. (Fig. 3.) A marked lymphocytic and polymorphonuclear leucocytic infiltration was present in the mucosa, submucosa and muscularis of two of the diverticula. (Fig. 4.) On the basis of these find-

ings, a pathologic diagnosis was made of diverticulosis of the appendix with superimposed subacute inflammation.

#### COMMENT

Diverticula of the intestinal tract are most commonly found in the large bowel, particularly the descending and sigmoid colon, and occasionally in the small intestine. In the colon they usually adjoin the appendices epiploicae and are of the false acquired type which frequently gives rise to symptoms. In the small bowel they are almost invariably situated along the mesenteric border and seldom produce symptoms. Diverticula of the vermiform appendix, however, must be exceedingly rare since we have been unable to learn of any recorded or unrecorded case similar to the one described. The appendiceal diverticula in this case unquestionably were of the true congenital type with superimposed subacute inflammation.



# RECONSTRUCTION OF THE COMMON DUCT WITH VITALLIUM TUBES

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SINCE the introduction of the vitallium tube by Dr. Pearse, of Rochester, New York, many cases have been reported in the literature in which the reconstruction was facilitated by the use of this type of a tube. Dr. Frank Lahey has raised the problem concerning the pressure caused on the neighboring blood vessels by such a tube and wondered if it would not be wiser to continue the use of rubber tubing. This is a legitimate question and can be answered only by following a large series of cases for years.

The following case is reported so that it may be included in this series as well as to point out some unusual experiences such as: (1) The accidental and fortunate establishment of an abdominal biliary fistula by surgery just at the time that the patient was on the verge of establishing his own bronchobiliary fistula; (2) the necessity for having many types of vitallium tubes ready on the operating floor; (3) the establishment of a gastrohepatic biliary fistula with rubber tubes which was blocked by the rotting away of one of the rubber tubes, and (4) the successful re-establishment of the normal connection between the two hepatic ducts and the distal end of the common duct with the aid of a "Y" shaped vitallium tube.

## CASE REPORT

Mr. A. R. was admitted to the Rhode Island Hospital on July 24, 1942, because of persistent, intense, painless jaundice. The past history revealed that he had had a cholecystectomy in another hospital in this city in December, 1941. Following the operation the patient had been well for three days. Then a large amount of brownish fluid drained through the incision. This drainage continued to be profuse for several weeks and then decreased in amount.

With the decrease and finally the disappearance of the drainage, jaundice, clay-colored stools and a severe itch set in. X-rays were taken and he was referred to the Tumor Clinic. It was decided at that hospital, according to the patient, that nothing else could be done. The patient was discharged. The jaundice increased in severity until the patient "looked like a Chinese." His appetite had been poor. Stools continued to be clay-colored and there had been a loss of twenty-five pounds in weight as well as a sapping of his strength and energy. On his doctor's recommendation he had several carious teeth extracted.

The physical examination on admission to the Rhode Island Hospital seven months after his cholecystectomy showed a thin undernourished ambulatory man of thirty-three; weight 105 pounds; blood pressure 94/65; icteric index 84; Van den Bergh immediate direct; hemoglobin 11 Gm.; red blood count 3,600,000; feces negative for bile; urine 4+ for bile. His temperature was 99°F., pulse 100, respirations 20. Except for a well healed upper right rectus scar and jaundice the physical examination was negative.

The prothrombin time was reported as 106 per cent of normal but the intern made a note that he must have made some mistake. X-rays showed no evidence of disease in the heart, lungs or upper abdomen.

The patient was prepared for surgery with vitamin K, high carbohydrate, high vitamin diet, etc., with the expectancy that he had one of the three following conditions: (1) injury to the common duct, (2) stone in the common duct, or (3) carcinoma of the head of the pancreas.

The operative note made on July 29, 1942, the day of the operation follows:

Preoperative Diagnosis: ? Injury to common duct or stone in common duct.

Operation Performed: Exploration of common duct.

Postoperative Diagnosis: Injury to common duct.



A right rectus muscle-splitting incision was made. On opening the peritoneum, numerous, dense adhesions of the omentum to the under-

them. The upper end of the remains of the common duct was rounded, so that there was no question that this was the upper end. The



FIG. 1. Photograph of x-ray following second operation. Only one of the rubber tubes could be visualized by x-ray.

surface of the liver were found. These were freed by sharp dissection. Bleeders were tied. The liver edge was round and the liver appeared slightly enlarged.

The common duct area was exposed and the foramen of Winslow identified. A thickened, normal-sized common duct was isolated. Two silk retraction sutures were placed in it and the duct opened. A probe was inserted down into the duodenum with no difficulty. The probe was then directed upward and found to meet an obstruction. The common duct was further dissected and a small stump, apparently the remains of the cystic duct, was identified. About one-quarter inch above this, the common duct terminated. Exploration failed to reveal any evidence of the upper portion of the common duct or common hepatic duct. The portal vein and hepatic artery were dissected free from surrounding tissue so that all structures in this area were definitely identified.

A needle was inserted into many suspicious areas but no bile was obtained from any of

needle was inserted into several areas in the liver in the hope of establishing a biliary fistula.

The head of the pancreas, stomach and duodenum appeared normal. The patient's condition was poor and the search for the upper end of the common duct had to be stopped after three hours and twenty minutes of operating.

A cigarette drain was inserted down to the foramen of Winslow and the wound closed in layers about the drain, using No. 00 chromic double continuous catgut in the peritoneum, single of the same in the muscle, chromic No. 0 figure-of-eight in the fascia. Four stay sutures were used and one cigarette drain inserted.

Discussion of this operation lead us to believe that the upper half of the common duct had been injured and that what was left had shriveled up so that the hepatic ducts were now intrahepatic. Moreover, my failure to locate the site had robbed this individual of his only chance to survive. Postoperatively,

the temperature spiked to 101°F. for about eighteen days. During the first eleven days the wound appeared clean and dry. There was no

pus cells, many bacteria, occasional pigment granule and rare crystal resembling cholesterol. Culture revealed many Gram-negative rods of

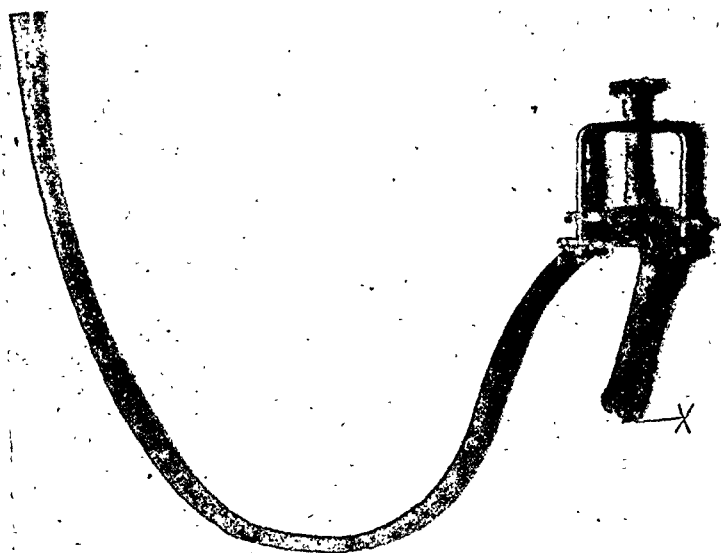


FIG. 2. Shows catheters removed. Note short tube pointing downward. It rotted away at x.

sign of bile. The sutures and drains were removed. Our wound had healed well and we attributed the temperature to a "hepatitis." On the twelfth postoperative day bile was seen on the dressing. A rubber catheter was inserted into the sinus and continuous suction was applied in the hopes of encouraging the flow of bile. Fortunately this happened and whenever there was a tendency for the sinus to contract down, dilatation was carried out.

The icteric index on August 1, 1942, three days postoperatively, rose to 96. On August 17, 1942, nineteen days postoperatively and five days after the appearance of bile on the abdominal dressing, it had dropped to eighteen and remained therabouts.

From the eighteenth to the forty-first postoperative day the temperature remained within normal limits. The patient's general condition improved and his own bile was fed to him in grape juice.

From the forty-second to the fifty-third postoperative days the patient had repeated chills with a rise in temperature to 104°F. The white blood count averaged about 17,000 with a fairly normal differential. Blood cultures were sterile. The bile, however, which had formerly been clear became muddy in appearance. Microscopic examination showed a number of

the colon group, *Streptococcus non-hemolyticus*, *Bacillus pyocyaneus*, *aerogenes* and *Proteus morgani*. Sulfadiazine was started with an initial dose of 3 Gm. and then 1 Gm. three times a day. We probably should have given more but were afraid to. The blood level ranged around 5 mg. per cent for the free and 8 mg. per cent for the combined. The last chill occurred on the sixty-fifth hospital day. From that day until his second operation the temperature remained normal. The patient, however, lost all of the ground that he had gained. He refused to take his bile even by gavage. His weight came down to 97 pounds. The serum protein was reduced to 5.8, hemoglobin 12.8; red blood count 3,750,000; cholesterol 202; icteric index 20; urine essentially normal. Three blood transfusions were given.

It was decided that something had to be done in order to get the bile draining into the gastrointestinal tract.

In view of the fact that the common duct was believed to be intrahepatic it was thought best either to dissect out the sinus and implant it into the stomach or small bowel or else to re-establish the connection of the biliary and gastrointestinal systems with a vitallium tube. A special tube was ordered with four holes bored into the widest end. It was hoped that

this could be sutured to the liver at the liver end of the biliary sinus and the smaller end would either be inserted into the distal half of the common duct or into the small bowel. This

foramen of Winslow was closed off and all the tissues in front of it were markedly edematous. Identification of the individual structures was impossible.



FIG. 3. Shows y-vitallium tube in place eight months post-operatively. Dense shadow in middle of stem of tube represents point of union of two tubes to give added length required in this case.

was the only vitallium tube which we had. The operative note follows:

Preoperative Diagnosis: Old common duct injury.

Operation Performed: Hepaticogastrostomy.

Postoperative Diagnosis: Same.

The abdomen was opened through an old right rectus scar. The biliary fistula was excised and was traced down to the right lateral wall and found to extend between this wall and the liver. The fistulous tract apparently led over the upper surface of the liver and not into the remnants of the common duct as was expected.

As soon as this was realized, this dissection was left alone and the undersurface of the liver was explored just above the foramen of Winslow. There were considerable dense adhesions of the omentum and duodenum. The

After considerable searching, a nubbing was encountered which appeared to be the upper end of the common hepatic duct. The tissue about this was very dense. It had to be incised with a knife. As this was done, a dirty, whitish, mucoid bile gushed out so fast that suction alone could not keep ahead of it. As soon as the bile had stopped flowing, the region was further explored. A culture of this bile was taken.

It was found to be just at the bifurcation of the hepatic ducts and the septum between the two hepatic ducts could be seen. The septum was incised in order to make it possible to put in the vitallium tube, but this was not enough as the amount of hepatic duct wall was very small. The vitallium tube was placed into the right hepatic duct using the straight, narrow end. It was sewed in place with difficulty but was quite firm when this was finished. A No. 12

French catheter, the end of which was cut, was then inserted in the left hepatic duct and sutured. This field was then walled off and the duodenum was identified. It was rolled out and the remnants of the distal common duct was found. A French clamp was placed into it and then found to go into the second portion of the duodenum. Another clamp was placed in the same opening, and it was found that it went directly posteriorly in toward the head of the pancreas.

Study and discussion ended in assuming that in this patient, the duct of Wirsung entered the common duct just before the common duct entered into the sphincter of Oddi. An attempt was made to bring this portion of the common duct up to the metal tube so that at least half of the liver would drain into the duodenum. This was found to be impossible as the gap was too great. Attempts to mobilize the duodenum were unsuccessful because of the profuse bleeding that was encountered. The duodenum itself could not be brought up to the metal tube without there being too much tension. In desperation, a small rubber catheter was placed through the metal tube into the right lobe of the liver and sutured to the four small openings which had been made in the end of the metal tube. These two catheters were then brought out over the stomach and the omentum above the stomach was lapped around them.

An opening was made into the stomach and a hole was made in each of the two catheters at this point. The catheters were then sutured so that the bile would empty into the stomach and the stomach wall was sutured over the two catheters in the hopes that a biliary fistula from the hepatic ducts to the stomach would be established. The open ends of the catheters were then brought out through the greater omentum, and the greater omentum sutured to the openings in the stomach and the catheters were brought outside the abdominal wall.

A rubber tissue drain was placed down to Morrison's pouch. The wound was closed in layers using four through-and-through heavy silk stay sutures. Continuous No. 00 chromic catgut sutures were placed in the peritoneum, and interrupted No. 0 chromic in the fascia.

Interrupted silk was used for the skin.

The operative time was close to five hours and needless to say the patient's condition was poor. We persevered because we realized that

this was the only chance which the patient had to survive.

Several interesting observations results from this procedure: (1) That at the time of the first operation this patient was apparently on the verge of breaking through the dome of his liver and establishing his own biliary drainage. It is quite probable that this would have developed into a bronchobiliary fistula and that our fortunate and timely interference provided the bile with an easier exit. This must have occurred on the twelfth postoperative day. The continuous suction likewise encouraged the development of this tract. (2) The swelling of the liver made the hepatic ducts intrahepatic at the first operation and the "deflation" of the liver associated with the drainage of bile made enough of the ducts extrahepatic so that we could see them at the second operation. (3) The various types of vitallium tubes should always be available at these operations as one can never tell what condition is present. (Fig. 1.)

Seven days following the second operation the icteric index rose to 35. On the fourteenth day it was 19, on the twentieth it was fourteen and on the twenty-ninth day it was 9 with a cholesterol of 268. The postoperative convalescence was unusually smooth. The temperature never rising above 100.5°F. and returning to normal on the eighth day postoperatively.

Drainage from the wound was moderate and ceased on the tenth day. Healing was excellent. The rubber catheters were unclamped only for pain and this occurred but twice.

The reason for bringing the tubes out through the abdominal wall may not appeal to some but it seemed to us to offer two advantages: First, that suction could be applied even though there was an opening into the stomach and secondly it might be possible to remove the tubes after a long interval had established a firm sinus, without submitting the patient to further surgery.

The patient was discharged with normal-colored stools 123 days after admission, 117 days after his first operation and thirty days following his second operation.

One month after discharge he weighed 135 pounds which was his normal weight.

On March 24, 1943, the patient was readmitted because of a vomiting spell and fear that something had gone wrong. He remained in the hospital for five days. The vomiting did

not recur. The feces were brown in color. Laboratory work showed: Hemoglobin 16.1; red blood count 4,570,000; white blood count 12,850; Van den Bergh direct reaction; icteric index 6; urea nitrogen 9; cholesterol 272; glucose 83; total protein 7; urine (normal) no bile present.

On July 11, 1943, the patient was readmitted because of epigastric pain which was referred to the right shoulder and jaundice. The temperature, pulse and respirations were normal on admission. Examination showed: Icteric index 18; Van den Bergh immediate direct reaction; white blood count 13,450; hemoglobin 14; red blood count 3,820,000.

The stools intermittently showed absence of bile. The temperature showed some fluctuation and the icteric index rose to 44 on the twenty-eighth hospital day. On the very next day the temperature returned to normal, the patient felt better and his icteric index gradually improved until it reached 17 on the thirty-third day since admission.

During this hospital stay it was realized that a "Y" vitalium tube would have to be inserted in place of our makeshift combination. A tube one and one-half times the usual length was ordered and had not arrived, so that the patient was discharged.

The patient was readmitted on August 23, 1943, because one of the rubber tubes had broken in half. Our vitalium tube had arrived earlier but the patient was getting around quite well and desired to postpone his operation as long as possible. We agreed, but this accident gave us the opportunity for attempting to insert our vitalium tube.

The laboratory work follows: red blood count 4,560,000; white blood count 17,450; hemoglobin 13.9; blood urea nitrogen 10; glucose 94; total protein 6.5; sodium chloride 468; icteric index 21; Van den Bergh immediate direct; urine ? bile; stools varying color but never clay-colored.

Operation was performed on August 27, 1943. The operative note follows:

Preoperative Diagnosis: Absence of the common duct due to trauma during cholecystectomy.

Operation Performed: Reconstruction of the common hepatic and common duct.

Postoperative Diagnosis: Same.

The abdomen was opened through the old right rectus scar. Dense, firm adhesions were

found throughout. The stomach was adherent to the undersurface of the peritoneum. An elliptical incision was made in the peritoneum and then around the stomach at this point. A tie was placed to close the mucosa which was not opened. Interrupted sutures were used in the muscularis and serosa of the stomach and reinforcing the first layer. The stomach and duodenum were firmly adherent to the undersurface of the liver. These organs were separated by blunt and sharp dissection so that finally the foramen of Winslow could be identified.

The finger was introduced into this foramen and the metal tube could barely be palpated. There was a great deal of thick, fibrous tissue where the common duct should have been and where the sinus probably was. This fibrous tissue was carefully dissected away from the right side toward the midline. The hepatic artery could be seen pulsating. An incision was made parallel and to the right of it in the peritoneum and fibrous tissue. This vessel was gently retracted toward the midline. The portal vein could not be identified at any point during the operation. The incision in the fibrous tissue sinus tract was carried down toward the metal tube. The end of the tube was uncovered and it was found to be firmly fixed in the liver substance. The ties which had been placed in the tube to hold it in position were finally seen and cut and the tube was easily removed. It was known that this tube was in the right hepatic duct. Careful dissection opened the left hepatic duct. A Kelly clamp could be placed in each one and it was definitely noted that the left hepatic duct extended toward the left and the right toward the right. The Kelly clamp could be inserted for quite a distance. The duodenum was rolled down exposing its posterior portion. The silk suture which had been placed on the distal end of the common duct was found and it was traced down to the common duct. This was freed and a definite wall lining the inside of the duct could be identified. The Kelly clamp inserted through this opening was found to enter into the duodenum. A possibility of this being the sinus tract opening was thus ruled out. The "Y" vitalium tube was then placed in position so that each limb of the "Y" entered into one of the hepatic ducts and the open end was inserted into the common duct.

A suture was placed through the opening provided in the tube. The tube was sutured to

the undersurface of the liver. Another suture was placed through the same opening and used to anchor the tube to the duodenum. Whatever tissue that was present was then used to make a covering for the tube so that a sinus tract could be established. The cigarette drain was placed toward the foramen of Winslow after 5 Gm. microcrystals of sulfathiazole had been placed in the peritoneal cavity and over the liver.

The wound was closed about the drain using No. 00 chromic doubled continuous to the peritoneum, four heavy No. 4 stay sutures through-and-through the abdominal wall, interrupted doubled No. 60 cotton in the fascia and interrupted cotton in the skin.

The surface of the liver was found adherent to the undersurface of the diaphragm. These adhesions were quite firm and were not disturbed. When the hepatic ducts were opened greenish bile containing some mucus had to be removed by suction. The patient was given a transfusion as well as intravenous fluids throughout the operation and he left the operating table in excellent condition.

Postoperatively there was considerable drainage of bile from the abdominal wound. The stools became clay-colored and the urine contained bile. The icteric index rose to 36. Temperature remained normal after the second postoperative day.

On the twelfth postoperative day the icteric index dropped to 17. Several days previously bile had been seen in the stool but the abdominal wound was still draining bile profusely. This gradually diminished and disappeared at the time of discharge. The icteric index was 11 on the twenty-second postoperative day when the patient was discharged with the bile flowing freely into the gastrointestinal tract.

Since his discharge and up to the present, a period of approximately twenty-four months this patient has remained well. There have been no recurrent attacks of chills, fever, malaise, etc., which are associated with ascending infection of the liver from the gastrointestinal tract and it is quite possible that these will not occur because the distal end of the common duct was used and the sphincter of Oddi will prevent infection from ascending to the liver through the vitallium tube. The patient has been free from pain and the icteric index has returned to normal. He has also returned to his former occupation. (Figs. 2 and 3.)

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## PRE-COLUMBIAN MIDDLE AMERICA MEDICINE

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THE American Indians from the north as far as the Dakotas to the south as far as the lower borders of Chile, had entered upon advanced stages of social and cultural development long before the land of the Americas was discovered by Columbus and his followers. However, it is difficult for the historian of the present to unravel the story which must have been presented to one, who in the early colonial period, would visit these ancient races in their native homes and villages. In but a few instances have definite pictorial records of their daily existence been handed down by these people. Even in our own country of the United States with its backward native civilization, the mound builders evidently had reached a high grade of a crude civilization centuries before the white man came. Because of absence of a written language, it is only by piecing together here and there objects found in these mounds that it is possible in a hazy and unsatisfying manner to form a concept of what the daily life of these early people might have been.

However, as we go farther south into Mexico and Central America and beyond into the Highlands of Bolivia, Peru and Ecuador, we find more permanent ruins and fairly well preserved archeological structures which indicate to us that a high culture had existed in this region centuries before Columbus came. The temples of the Toltecs, Zapatecs, Chimus, Incas, and the Mayas built of enduring stone indicate the high plane of civilization attained by these ancient peoples. We

know that the Aztecs and those who preceded them, the Toltecs, and even before that, the more ancient people called the Archaic race, had developed the arts of peace as well as those of war to a high degree. We also know that the Incas of Peru and the preceding race, the Chimu, were of high intelligence and great ability. As they gradually learned to produce the architectural wonders which even in their ruins astound us, we must give them credit for having been advanced in other fields of human endeavor. The conclusion is impressed upon us that many generations of thinkers must have brought to these intelligent peoples some ideas of the causes of disease, and the experiences gained in their contemplative philosophy must have aided them in developing a system of therapy by which they sought to cure or to remove the ills to which their bodies were subjected. However, since they were not acquainted with the physical make-up of their body and only knew in a hazy manner a few of its functions, they were engulfed in a sea of uncertainty and ignorance. Out of this void of uncertainty by sheer intellectual effort, contemplative study, and comparative deduction, they groped their way to their own metaphysical interpretations of the phenomena of disease. Naturally their conclusions were full of distortion and error. As a corollary of an existence which was full of terror, uncertainty and dread, they associated the many ills of the body with the activities of demons or of evil spirits who had entered into and took possession

of it. By holding to such a philosophy it is easy to understand how the cult of the priest and that of the physician in time became almost indistinguishably welded.

The priest was supposed to understand the habits, languages and motives of the spirit world and was regarded as competent by the exercise of exorcism and magic to remove unwelcome visitors of the spirit and demon world who, entering into the body, had caused its suffering and disease. When the processes of exorcism became too involved and complicated, specialism took place in the ranks of the priesthood. Especially was this so in the Americas among the Mayas. Gradually a group of the priesthood assumed as their own particular prerogative the practice of the healing arts and the care of the sick and injured. The members of this specialized group were called Shamen. It is interesting to note that the term Shaman was generally used among primitive people over almost the entire world to designate the type of individual who was entrusted with a combination of ecclesiastical and medical duties. We find that the priestly doctors were called Shamen in far northern Siberia, in the Alaskas, among the Polynesians and the early Egyptians. We also find the term is used to designate a form of minor priesthood in the Hebrew religion where the shaman has somewhat the same standing as the elders in the Presbyterian church. The traveler in South America and in certain parts of Central America, especially in the Highlands of Guatemala, will find that where the customs are still primitive and Catholic priests are unavailable, the party or person who takes the place of the priest is called a shaman. It would be an interesting diversion to dwell upon the universal and wide use of this term as an indicator of the common ancestry of certain components of the human race and to speculate upon the interrelation of various tribes and peoples.

Among the American Indians the shaman also had a place of high respect for we find that in the early Indian religion

that the shaman was entrusted with special duties and had assumed definite obligations. Among the Mayas and the Toltecs, one of the duties of the medicine man or priest-physician was to administer at the religious services to the serpent god.

We know that folk customs and practices are particularly tenacious and are hard to change since they have sunk deep into the very roots of racial existence so that even in this enlightened day we find that a type of serpent worship still persists in widely separated regions. This worship is serviced by particular and specialized ceremonies as illustrated by the serpent dances of the Hopi Indians, by whom the serpent is regarded almost with veneration. We even find in the legends of the early Hebrew and Christian religions that at times the serpent was held in a venerated or deified position and even as a repository of wisdom was accused of having tempted Eve to seek forbidden knowledge by eating of the apple. In this manner the serpent in his evil power was associated with the downfall of man.

We may permit speculation as to the reasons why the serpent had acquired such a hold upon the imagination and philosophy of primitive man. It is likely that his reverence for the serpent and his belief of its association with occult power and lethal influence might to some extent be explained by the mystery of its mode of existence, its silent and unexpected appearance from the recesses of the forest with its graceful forward movement without legs, its very long life which seemed to partake of life everlasting, the periodical casting off of its skin by which it was thought to reincarnate itself, its long disappearance into the depths of the ground where it apparently became associated with the demon gods of the nether world, and its ability to kill with the poison generated in its own body. All of these fired the primitive imagination which clothed the serpent with supernatural powers. As the most important of these many attributes the serpent was thought to have



knowledge of good and evil. He was regarded as a teacher of wisdom and a prognosticator of future events and as the dispenser of health to those whom he condescended to aid. The latter attribute or power probably explains the association of the serpent with the healing art.

It is also easy to understand how in early anthology this worship with its sinister implications could become the embodiment of all that was evil. Because of the stealthy approach of the serpent and its unannounced presence it became an object of fear and dread. As a consequence, effort was made to appease it, and in the course of time it was elevated to the rank of a deity. As man's ability to live and survive depends upon the vigor of his body and his freedom from destructive disease and crippling accidents, it is not surprising that he sought to appease and propitiate this serpent god who was so potent for good or for evil.

In consonance with the tendencies of other races of the world it is not surprising that the American Indians, especially the Toltecs and Mayas, developed a well defined cult of medicine and that this was associated with the worship of the serpent god. The priests of this cult were regarded as skilled in the arts of healing the sick and in the treatment of wounds. This reputation was well merited because in the course of many generations they had accumulated a considerable fund of knowledge and were expert in the treatment of disease. As is usual with all groups who possess special skill, they finally organized themselves into a kind of brotherhood which required that novitiates be scrupulously selected both for intelligence and natural ability, and that after selection they be put through a rigid course of instruction and training. It is significant of a constantly increasing restrictive tendency that among the Aztecs and the Nahuas of ancient Mexico the medical priesthood was hereditary and descended from father to son, from generation to generation. This same procedure was

noted in Chile by Ovalle whose observations were made in 1649. Education was under the father's guidance and in Mexico opportunity for practice in the public hospitals was given. There was also free access to the botanical gardens. Anatomical knowledge was advanced by dissection of the bodies of the persons killed during sacrificial ceremonies.

The Maya Indians regarded the medicine man with great reverence and respect and designated selected boys at an early age for this high calling at the age of ten or twelve years. Boys destined for the priesthood were selected because of their natural inclination and their peculiar aptitude and intelligence. They were required to have a strong pulse and a healthy body. After selection they were segregated into special schools where they were instructed in the obligations and duties of their high office. They agreed to remain in celibacy for twenty years and had to respond to all calls of the sick and afflicted. For at least a period of their instruction they were confined in solitary buildings where they dwelt in company with their instructors. For the first two years they were subjected to severe discipline. They must not eat flesh nor anything having life, but live solely on vegetables, drink only water and not indulge in sexual intercourse. During the probationary term neither parents nor friends were permitted to see them. At night only were they visited by professional masters who instructed them in the mysteries of necromantic art.

Among other Indian tribes it was required that a young man desiring to become a medicine man would first have to find a competent teacher who was willing to accept him as a student. After a prescribed period of training both teacher and student apprentice retired to a hut in the forest where the novice was instructed in the more intimate ceremonials and the incantations and medical practices required of the medicine man for proper functioning of his art in the treatment and cure of

disease. When the period of instruction was completed the apprentice was left alone in the hut and was then supposed to encounter a serpent (boa-constrictor), which reared up and placed his tongue in the mouth of the young man and transferred to him the wisdom of his calling. In this way the initiation was completed. Among some of the Maya tribes three novices were assembled at one time and at the end of the investment ceremony each of the novices was supposed to be devoured by a snake and was later expelled through the anus. In his passage through the snake, the novice was supposed to acquire the knowledge of various herbs and drugs and medical practices.

After his education was completed the neophyte entered upon the practice of his profession and was granted the privilege of wearing the insignia of the medicine man. In some tribes, as the Wabeno tribe of North American Indians, (Schoolcraft, H. H.), a musci scroll of medical or magical significance was given to the student on completion of his course of training. From the presenting symptoms he made his diagnosis and prescribed his treatment. Empirical diagnosis based upon symptoms was not always easy and in some cases required considerable intelligence of a high type.\*

The medicine man not only prepared the medicine which he used but he frequently administered it. This was accompanied by proper ceremonial incantations and ritualistic formulas by which such assurance was conveyed to the patient that he became convinced of the authoritative source of the methods used in his treatment. Incantations were also used to qualify the diagnosis and to indicate the proper drugs and practices to be used in treatment. They also were the means of determining the prognosis of the particular condition from which the patient was suffering. In the medical seances the

rapport or sympathetic relationship between patient and medicine man was very considerable. By the hypnotism of his calling the medicine man had become convinced of his own power and was acting in most cases in entire harmony with both his patient and his art, so that the patient imbued with the confidence displayed by the medicine man, did not doubt his ability to bring him into contact with the spiritual world through which he would obtain relief. As an aid to this state of mutual accord a mild intoxication was induced in both medicine man and patient by the administration of narcotics or by the drinking of intoxicating liquors. The *Datura* or ginseng weed of the southwest, or tobacco which was indigenous in all the Americas, was frequently used. A state of half consciousness was induced; in this trance-like state hazy and half formed visions would materialize. These visions embodied the ideas and conclusions suggested by the medicine man. Also certain things which the patient was to avoid and which were to be taboo were suggested to him in his narcotic semi-consciousness.

The members of the tribe usually had great respect and reverence for the medicine man who usually was of outstanding personality and shrewd intelligence and carried himself with great dignity. By his skill and cunning he was able to deceive the simple minded members of his tribe. He impressed them with the magnitude of his powers and developed a position of respect and prestige for himself and his art. This was very necessary for his success because the medicine man was held to be particularly qualified to treat disease because of his intimate contact with the spirits of his ancestors. Also he was thought to be in communion with the gods who were represented in the various birds, quadrupeds and reptiles whom he had encountered in his journey through life. From them he was supposed to have learned many intimate qualities of life's mysteries.

\* BANCROFT, H. H. *Native Races of the Pacific of North America*. New York, 1875-1876. D. Appleton & Company.

By his superior knowledge of the elements he was credited with the ability to see into the future and was regarded as qualified to predict changes in the continuance of an individual's health and the onset of disease. In difficult cases he was supposed to see and hear the spirit of the patient and thereby was able to understand better the spiritual and physical conflicts occurring in the patient. From this knowledge he was considered as capable of prognosticating the course of the disease and the prospects for recovery. The medicine man not only impressed his followers with his ability in the healing arts and in the cure of human ills, but also with his general superiority in all lines of endeavor.

In the treatment of disease his methods may be formulated into (1) the rituals and mysteries of sorcery, (2) incantations and mummeries of magic, (3) in his more material therapeutics he made use of organic substances, animal or vegetable, and inorganic substances, minerals, etc., (4) manipulative procedures, (5) physical measures as baths, blood-letting, etc., and (6) surgical procedures.

In the practice of sorcery and magic, incantation usually was associated with dancing which was regarded as a necessary part of the procedure. This dancing consisted of strenuous movements of a ceremonial character with a shuffling two step and a third step in between, by which the entire movement was exaggerated. The dance was accompanied by a chant; both dance and chant were of almost interminable duration, so that they frequently were terminated by the medicine man and his acolytes falling down unconscious from exhaustion.

An example of the procedure of medical divination as practiced among the ancient Mexicans is given by Nuttall as follows: "When someone was ill they called the medicine woman or man in order to ascertain how the illness would end, and placed an idol in front of the patient. This idol was named Quetzalcoatl, or 'Plumed serpent.' On entering the house

permission was asked of the household god. A demijohn of balche, an intoxicating liquor, was received and during the procedure the shaman kept himself goodly intoxicated, according to Meetal.\* A mat was laid upon the floor and the medicine man or woman sat on this and in front spread a white cotton cloth. The shaman then took twenty grains of maize in his hand and cast them upon the white cloth, just as the Spaniards cast dice. If the said grains fell in a circle, leaving an empty space in the center, it was a sign that the patient would die of his illness and would be buried, the empty space being regarded as the sign for a grave. If the grains fell on top of each other, it signified that the illness had been caused by sorcery or witchcraft, but if in falling the grains divided into two parts, one half being on one side and one on the other, so that a straight line could be drawn through the middle of the group without touching a single grain, it was a sign that the disease would leave the patient and that he would recover."†

Types of sorcery and magic somewhat similar to that of other ancient days are at present being practiced among the descendants of the Mayas, by individuals who combine the functions of priest, sorcerer and physician. These "yerbateros" of today are called Ah-men by Roy's and H'men by Starr.

"These on occasion might undertake to cure disease or to provide a love potion." (Shattuck quoting Roy's—Roy's 1931 *Ethno Botany of the Mayas* quoted by Shattuck, George C. *The Peninsula of Yucatan*, 1933, P. 64, pub. Carnegie Inst. Washington, D.C.)

In more materialistic application of the therapeutic art are to be grouped methods of the Maya and the ancient Nahuas who lived in what is now Mexico. They, like all other peoples, subscribed to the prin-

\* MEETAL, B. T. *Medicine in Ancient America. Hygeia*, 13: 343, 1935.

† Sorcery, Medicine and Surgery in Ancient Mexico, by Nuttall, *Z. Johns Hopkins Hosp. Bull.*, April, 1902.

ciple that "like cures like." So it happened that many Indian tribes, the Mayas in particular, treated a disease with objects which would produce changes similar to those present in the disease, such as the application of crushed wasps nests or other stinging insects for skin eruptions or the decoction of yellow plants for jaundice. (Ciba Symposia; 1: 13, 1939.)

In the more material concept of disease as being due to disturbances of the structures of the body and in his rationalization of methods of treatment of disease, some tribes of the early American Indians, especially the Mayas and the Aztecs were as far advanced, if not farther, at least in some respects than the contemporaneous Europeans. This was confirmed by the Spaniards who noted that Indian medicine was far advanced and they marveled at its sufficiency. Such a high proficiency is quite conceivable, because it is understandable how an intelligent but primitive people can marshal observations and formulate them into conclusions from which concepts of astounding accuracy may be deducted. These crude concepts of the early Indian medicine men are startling in their similarity to those which were later formulated by trained observers who had at hand a wealth of scientific data. It is therefore, not surprising that the medical and therapeutic methods and procedures of the Aztecs and Mayas were rich in innovation and qualified achievement, though they were entirely different and at times were at variance yet in some respects were far in advance of the practices of the civilization of the old world. For instance, their method of treating wounds was an example of their advanced technic in that they coapted the edges of an incised wound with hair sutures. After closure, the wound was bathed with the juice of the agave plant. However, if the wound had healed badly and had left an ugly mark, it was reopened and was cauterized. It was again sewed with hair and covered with melted ulii which is the juice of the India rubber plant.

In the treatment of disease the Indian used herbs, roots, leaves or twigs, occasionally seed flowers. Animal substances, insects, earth and minerals were also included in the therapeutic armamentarium. From these substances extracts and infusions, powders and concoctions were made. These were given to the patient to drink or were applied to the surface of the body. Indian medicine men were acquainted with and used preparation of narcotics, sedatives, purgatives, emetics and stimulants. They used hemastatic substances to control bleeding and applied healing and cleansing solutions for wounds. They also were acquainted with physical methods of treatment such as massage, scarification, venesection, counter-irritation, bandaging, poulticing, tooth pulling, cupping and sucking. They were able to set fractures and apply splints. They also applied manipulation by pressure and controlled hemorrhage by tourniquet. They also used cauterization. Some of these practices were based upon observation but many, however, were thought by the Indians to be the result of a supposed mystic and supernatural directional guidance obtained by the medicine man from the spirit world. It is interesting to know that the American Indian used fifty-nine drugs which are now included in modern pharmacopeias.\*

Drug preparations which have been found valuable, and are now in universal use, were indigenous among many Indian tribes and were originally used by the Indians are: *canabis indica*, *cascara sagrada*, *chapparro*, *chenopodium*, *condurango*, *cocoa*, *copal*, *guaiac*, *hualtata*, *hydrastis*, *ipecac*, *jaborandi*, *jalap*, *krameria*, *mandragora* (I believe this was already known in Asia Minor), *peruvian balsam*, *sabadilla*, *sarsaparilla*, and *tolu balsam*. In addition to their medical practice, Indians were accustomed to embalm and to cremate. Isolation was used in the treatment of cer-

\* Stone Age Medicine among the American Indian. New York, 1932. Hoeferm, Quoted from Ciba Symposia, W. M. Grogman, 1:11, April, 1939.

tain infectious fevers. Drugs were sold in open markets in special areas of these markets. To supply one of such markets the emperor Montezuma had established a botanical garden in which practically all the drugs used by the medicine men of his realm were grown. This garden was very extensive. Most of the three thousand plants used by the Mexican Indians in the treatment of disease were cultivated. Strange to say, these early Indians had rubber syringes which they used for giving enemas. Circumcision was also practiced. They also used flowers of *datura stramonium*, the so-called jimson weed, to produce twilight sleep.

The present day Indians of this continent may well be proud of their pre-Columbian ancestors who along with their other arts and sciences, especially astronomy, developed medicine to a remarkable degree. In the present article it is

impossible to consider in more detail the diseases of the Indians, the physical deformities from which they suffered, also the detailed methods of treatment which were in use especially by drugs and other means. It is interesting to know that hospitals had been erected by the Aztecs long before the coming of the Spaniards and that in some areas the infectious diseases which they had learned could be communicated from one to another were segregated in special areas and buildings.

It will also be interesting to compare the treatment practiced at the time of the conquest with that prevalent in Europe, and to learn how many methods, innovations, and improvements in practice were introduced into European medicine from the suggestions obtained by the Spaniards from the great Indian races of the western hemisphere.



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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-fourth Year of Continuous Publication*

NEW SERIES VOL. LXX

DECEMBER, 1945

NUMBER THREE

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## Editorial

### CONDITIONED TO THE DISC

FORTY years ago the most fashionable designation for a pain in the belly was appendicitis. Today the most fashionable designation for a pain in the back with radiation into a lower extremity is a "disc lesion."

There is a great similarity in the reaction of the medical profession and the lay public to both of these manifestations of a pathological condition. There is, however, a profound difference. The inflamed appendix threatened death; its removal under proper circumstances removed both the threat of death and the painful manifestations. The therapeutics of the newly discovered disc never involves the threat of death, but only the relief, in general, of a more or less transient pain or disability.

That to the degenerative lesions of the lower lumbar intervertebral discs are to be ascribed an important rôle in the clinical manifestations of "low back" disability can not be denied. Indeed it is remarkable that the first student of the pathology of the intervertebral disc, Schmorl of Dresden (1925), recognized "nuclear protrusions" only in the sense of "nodes" protruding into the centrum of the vertebral body. Furthermore, Danforth and Wilson (1925) despite their acute observation that the lower lumbar intervertebral foramina decrease in size from above downward, found

no disc "herniations." Mixter and Barr (1934) forcibly pointed out the rôle of "herniations of the nucleus pulposus."

The adult human lumbosacral region is no doubt a weak area from the biological standpoint. It shows the evidences of wear and tear, as do human feet, by virtue of late adaptation to the upright posture. In the main the race accepts these as temporary, intermittent, and sometimes chronic handicaps, and has found minor means to circumvent them, either by the employment of rest, heat, exercises, manipulation, or artificial support, and in view of the usually temporary nature of the symptomatic manifestations, it is not surprising that any one or a combination of such means is apt to be credited with the "cure."

There are however, at least three causes of low back pains and "sciatica" which cannot be dismissed so easily: (1) Intrinsic lesions of the vertebral column, and spinal cord, such as primary or secondary new growth; fractures and dislocations; inflammatory processes, such as osteomyelitis, Pott's disease, and Marie-Strumpell's arthritis. (2) Gross developmental abnormalities such as spondylolisthesis. (3) Neurotics and litigants. It is easy to assume that this or that person with a backache is a neurotic or that this or that

person, having suffered a low back "sprain" is actuated consciously or unconsciously by a desire for gain or to seek consciously or unconsciously, surcease from an uncomfortable set of environmental circumstances but such an assumption should not be made without a thorough investigation of the patient. In the early days of the appendicitis era, the neurotic patient, usually a female, was exposed to successive laparotomies, and indeed, invited them, and came to be known among surgeons as "surgical junk." The neurotic and the "low back" litigant of our day is in a fair way to be thrown upon a similar junk heap by the employment of injudicious operations.

There exists, however, a distinct field for surgical operations on the low back. A patient, comparatively free of neurotic or litigant factors, who is a subject of chronic invalidity or of recurrent acute episodes of acute and painful disability with its resultant physical incapacity, is a fit subject for surgical intervention. Occasionally a neurotic or a litigant may derive proper benefit from such interven-

tion if the circumstances are favorable or if there is a gross structural defect.

As to the form of surgical intervention in recalcitrant cases, this much may be said. There is occasionally a case in which the "sciatic" symptoms are so severe, with muscular atrophy of pronounced degree, and with reflex and sensory changes, as to warrant intraspinal exploration for an assumed nuclear protrusion. Should such gross protrusion be found (which is by no means the rule), the patient will get relief of the radiation symptoms, but will be left with a structurally weak back by virtue of the collapse of the disc.

The primary function of surgical operation for the "low back" of the recalcitrant type is stabilization of this structure. Stabilization will alleviate not only the symptoms of radiating pain which are produced by motion and strain, but may be expected to, in definitive fashion, correct the underlying weakness of structure. Hibbs found it out more than forty years ago, and his observation holds good today.

ARTHUR KRIDA, M.D.



# Original Articles

## HEMORRHAGE AS THE MOST FREQUENT CAUSE OF MATERNAL DEATH\*

AN ANALYSIS OF THE PUERPERAL DEATHS IN BROOKLYN, 1944

CHARLES A. GORDON, M.D.

BROOKLYN, NEW YORK

EACH year since 1935 the Brooklyn Gynecological Society has devoted the May meeting to a discussion of maternal mortality. And since 1938, with the cooperation of the Commissioner of Health of the City of New York and Mr. Thomas S. Duffield, Director of the Bureau of Records and Statistics of the Department of Health, as well as the Visiting Nurse Association of Brooklyn and every hospital, the Brooklyn Committee on Maternal Welfare has been able to present to the medical profession a detailed analysis of the maternal deaths which have occurred during the preceding year.

In the City of New York there were 132,735 births in 1944. The largest number of births occurred in the Borough of Brooklyn, 51,082; of these, 3,502 were non-white. The puerperal mortality rate per 10,000 reported terminated pregnancies, standardized for color, declined to a new low level in the entire city to 16.6. Calculated in the same way, the official puerperal mortality rate for Brooklyn is 12.4, the lowest of the five boroughs, and the lowest rate, I believe, yet recorded for any borough of the City of New York.

In the entire city of New York there were 222 puerperal deaths and an additional twenty-six deaths associated with pregnancy and childbirth, but not assigned to puerperal causes. In Brooklyn there were sixty-two puerperal deaths, and eight others officially assigned to non-puerperal causes.

In the following tabulation of the Bureau of Records and Statistics the puerperal causes of death are separated for statistical study. The year 1943 is added for comparison. (Table 1).

TABLE 1  
PUERPERAL DEATHS—BROOKLYN 1944

|         |                                      | 1944   | 1943   |
|---------|--------------------------------------|--------|--------|
| 140-141 | Abortion.....                        | 10     | 19     |
| 142     | Ectopic.....                         | 3      | 9      |
| 143-146 | Hemorrhage.....                      | 8      | 20     |
| 144-148 | Toxemia.....                         | 11     | 19     |
| 147     | Infection.....                       | 20     | 20     |
| 145-149 | Other diseases and accidents         | 8      | 16     |
| 150     | All other.....                       | 2      | 9      |
|         | Total.....                           | 62     | 112    |
|         | Reported terminated pregnancies..... | 51,082 | 55,660 |
|         | Rate.....                            | 12.4   | 20.5   |

We have learned that no complete analysis of maternal mortality may be made without giving due weight to the deaths assigned to puerperal causes secondarily. Yet we know that even those secondary causes which appear in the puerperal death column itself do not figure in computations from which important deductions are made. It is certain that observation of any maternal death problem must be critical to be valuable. And conclusions should be drawn, not from study of official figures alone, but after review of the case records which illuminate

\* Read at a meeting of the Brooklyn Gynecological Society, May 4, 1945.



the statistics. But for the rules which govern the statistician, three more cases may have been added to the total of puerperal deaths. The essential data of these three cases follow:

CASE I. *Assigned to cardiac disease:* A young primigravida undelivered, who had excellent prenatal care, died of heart failure after fifty-six hours of labor.

CASE II. *Assigned to chronic nephritis:* A primipara, aged thirty-eight years, with chronic nephritis, died of shock shortly after cesarean section.

CASE III. *Assigned to chronic nephritis:* A multipara in the sixth month of pregnancy with severe hypertension, partial separation of the placenta and fetal death was treated by Voorhees bags, followed by version, craniotomy, decapitation and manual removal of the placenta under general anesthesia; laceration of the cervix was repaired, and the vagina was packed to control bleeding. Death was directly due to uremia sometime later.

#### DEATHS EARLY IN PREGNANCY

There were thirteen deaths early in pregnancy, ten due to abortion and three to ectopic pregnancy. Hemorrhage was the actual cause of death in no less than seven cases of abortion. In one case death followed sudden profuse hemorrhage at home two days after spontaneous abortion. In two cases hemorrhage was so severe during removal of retained tissue, that operation was stopped and the uterus packed; and in another case profuse and repeated hemorrhage caused death after vaginal hysterotomy for missed abortion.

In all three cases of ectopic pregnancy intraperitoneal hemorrhage was great. In one case death was directly due to wound rupture and intestinal obstruction. The cause of death in the other two cases was discovered at autopsy. In one case death occurred one hour after admission to the hospital; and in the other the diagnosis was repeatedly missed, death in shock occurring three hours after re-admission to the hospital.

#### TOXEMIA OF PREGNANCY

In this group of eleven cases, six women died before delivery. In one of these cases death was directly due to anesthesia, and the case report does not mention toxemia. A multipara, with three normal deliveries previously was taken to the delivery room after long but poor labor. Forceps delivery was attempted under open drop ether anesthesia. Death from aspiration of vomitus occurred before delivery.

In the delivered group of five cases, prenatal care was good in but two cases. In the two cases in which cesarean section was performed, death was due to nephritis in one case and to peritonitis in the other. In two cases hemorrhage was an important factor in death:

CASE IV. Eight days after spontaneous delivery, a primipara with severe pre-eclampsia bled profusely from the vagina for several hours before placental tissue was removed from the uterus. On the following day the patient left the hospital against advice. After further bleeding at home for a week, she was admitted to another hospital where, a few days later, she died of severe secondary anemia and vascular disease.

CASE V. A primipara after low forceps delivery under open drop ether anesthesia suffered a profuse postpartum hemorrhage. During the next three hours she was given ergotrate, morphine, adrenalin, oxygen, intravenous glucose and 250 cc. of plasma.

#### INFECTION

Infection is the largest group statistically. In only six cases was another puerperal cause coded secondarily, as follows: hemorrhage (1), toxemia (3) and cesarean section (2). A primipara, aged nineteen years, discharged from the hospital on the fifth day after normal delivery, died of diffuse peritonitis at home one week later. And a multipara died of massive pulmonary embolism in the hospital on the sixth day after home delivery.

The trauma and shock of operative pelvic delivery were important factors in two

cases in which hemorrhage apparently was not significant.

CASE VI. After fifty-three hours of labor a primipara was delivered of a large stillborn fetus under deep anesthesia by difficult high forceps, after incision of the cervix. Though blood loss was not more than 400 cc., profound shock followed immediately. Death which occurred before transfusion could be completed was attributed to pulmonary embolism.

Severe hemorrhage occurred in seven patients in this infection group, one of them associated with rupture of the uterus. The essential facts of three interesting cases will illustrate:

CASE VII. After forceps delivery of a multipara, the placenta was retained. Manual removal and packing of the uterus followed, though bleeding was said to be moderate. Uterine contraction could not be maintained. Death in shock occurred after administration of plasma and oxygen.

CASE VIII. Severe postpartum hemorrhage occurred three hours after midforceps delivery of a stillborn infant. Treatment consisted of vaginal pack, sandbag over the uterus and plasma. Death one hour later was attributed to pulmonary embolism.

CASE IX. A young woman, gravida ii was admitted to the hospital in shock after a blood loss of 2,000 cc. at home. No fetal heart could be heard. Her condition improved after transfusion of 500 cc. of blood and 500 cc. of plasma. A few hours later a diagnosis of central placenta previa was established by vaginal examination, and a Voorhees bag was inserted in the cervix after gentle manual dilation. Shock recurred. Another 500 cc. of blood and two units of plasma were then administered simultaneously. The bag was removed, the cervix manually dilated and version and extraction performed. The placenta was removed manually. Death on the ninth day postpartum was due to pulmonary embolism, proved by autopsy.

Actually there was but one case of toxemia in the infection group, and, in this case death was ascribed to pulmonary embolism, though it occurred during a severe convulsion. Every year in the study of a large infection group it has been our

experience that it contains a very considerable number of cases difficult of exact assignment to any one particular cause of death.

#### CESAREAN SECTION

Cesarean section contributed to death in eight cases. In five cases in which the classical operation had been performed, death was due to infection; and in three of these cases sulfanilamide had been left in the abdomen. In one case of placenta previa associated with profuse antepartum hemorrhage, death, weeks later, was directly due to infection; 250 cc. of blood were administered nearly three weeks after operation. In two other cases death within one hour after operation was attributed to shock; plasma was administered, but blood was not available for either of these women.

#### RUPTURE OF THE UTERUS

We are aware that, since 1937, approximately 6 per cent of our maternal deaths, exclusive of ectopic pregnancy and abortion have been due to rupture of the uterus.<sup>4</sup> Generally thought to occur infrequently, its importance as a considerable increment of maternal mortality rates is not generally appreciated. In 1944, six women died of this cause.

In four cases diagnosis was not made until after death, and in one of these cases the uterus had been explored, after version and manual removal of the placenta. In three cases rupture was spontaneous, one of them due to previous cesarean section. Version was the cause of rupture in two cases, and rupture was due to manual rotation and forceps delivery of a hydrocephalic fetus in another.

Blood replacement was inadequate. In only one case did the patient receive blood, and in two cases plasma was administered. Only one operation was performed in this group. In this case rupture occurred in the hospital after twelve hours of labor. Death occurred four hours after hysterectomy. Plasma was administered, but not blood.

## HEMORRHAGE

Statistically only eight cases were assigned to this cause as the principal cause of death, and in three more cases hemorrhage was coded as a secondary cause. In the total number of thirty-five cases which I have assigned to hemorrhage, I do not contend that death was due to blood loss alone, for in some of these cases death was finally due to embolism or peritonitis or some other form of puerperal infection. Only those cases are included in which hemorrhage was said to be profuse or severe, or when the uterus was packed or ruptured. Cases of shock or sudden death are not included if the case record stated that blood loss was moderate or not excessive. The following case, for instance, is not included:

CASE X. An obese primigravida, age thirty years, after eighty-nine hours of poor labor was taken to the delivery room when she became exhausted and irrational. Her temperature had risen to 101°F. and the pulse rate was 140. Since the fetus was dead, its head was perforated. The patient died undelivered shortly afterward.

Time will not permit of a detailed account of all the cases in which hemorrhage was a prominent cause of death. Some of them have been related elsewhere in this report. Brief descriptions of cases which illustrate different situations follow:

CASE XI. A primipara who had previously been admitted to the hospital for bleeding in the eighth month was readmitted, bleeding actively, after twenty hours of labor. Two hours later, unattended delivery in bed was followed by profuse hemorrhage and shock. The uterus was packed and plasma and 750 cc. of blood were administered before death.

CASE XII. A primipara bled repeatedly from placenta previa before entering the hospital when bleeding became profuse. A Voorhees bag, which had been introduced with weight attached, was expelled one hour later. Version and extraction, difficult because of a nine pound fetus, followed. The uterus and vagina were packed without controlling hemorrhage. Oxytocics, oxygen and 1,000 cc. of plasma were administered.

CASE XIII. A primipara early in labor bled vaginally so the membranes were ruptured artificially. Two hours later spontaneous delivery of a dead fetus was followed by profuse hemorrhage and expulsion of the placenta. Hemorrhage was repeated at intervals for three hours when death occurred in shock. Coramine, caffeine, morphine, adrenal cortex and 1,000 cc. of plasma were administered, and the uterus massaged. Upon examination of the placenta, two cotyledons were found to be missing.

CASE XIV. A primipara admitted to the hospital with vaginal bleeding received 500 cc. of blood and 500 cc. of plasma. Delivery was effected by low forceps four hours later. Spontaneous expulsion of a separated placenta was followed by 2,000 cc. of old blood. The uterus was packed, and coramine, caffeine and an additional 500 cc. of plasma were administered. Blood was available, but it was not compatible.

CASE XV. A primipara with severe pre-eclampsia in the eighth month of pregnancy was admitted to the hospital bleeding profusely from the vagina. Hypertonic glucose and 1,000 cc. of saline were administered. When fully dilated seven hours later, version was performed. Shock and death followed.

CASE XVI. In her second pregnancy a primipara who had been previously delivered spontaneously of a small baby, and who was subjected to a sequence of long labor, failed high forceps, failed version, craniotomy, another trial of version, amputation of the fetal arm and failure of decapitation, died of hemorrhage and shock. The uterus was not ruptured.

CASE XVII. A primipara with rheumatic heart and hypertension was admitted to the hospital for rest in the thirty-third week of pregnancy. The membranes were ruptured artificially about ten days later, and when fully dilated, delivery was effected under ether-oxygen anesthesia by mid-forceps and episiotomy. The next day a large hematoma of the perineum and buttock was opened under ether anesthesia, and 400 cc. of clots evacuated. Shock followed. She later bled through the pack and was repacked twice later; 500 cc. of blood were administered. Death forty-eight hours after delivery was due to hemorrhage.

Hemorrhage was so commonly encountered in our case reports that we again find

it necessary to revise official figures in order to learn its true importance. The information on our certificates of death is for the most part reliable, yet we cannot expect them to show all the circumstances which surround maternal death. Nor can the Bureau of Records and Statistics do any more for us than tabulate the causes which appear on them.

Hemorrhage was a critical factor in thirty-five of the sixty-two cases assigned to puerperal causes of death, or 56 per cent of the total. This is greater than in 1943. Two cases of death from hemorrhage assigned statistically to the non-puerperal group are not included. The following table will show the importance of hemorrhage as a critical factor in the principal causes of death. (Table II.)

TABLE II  
PUERPERAL DEATHS—BROOKLYN 1944, HEMORRHAGE AS A CONTROLLABLE FACTOR\*

|         | Causes         | No. as of Statistics | No. with Critical Hemorrhage Factor |
|---------|----------------|----------------------|-------------------------------------|
| 140-141 | Abortion.....  | 10                   | 7                                   |
| 142     | Ectopic.....   | 3                    | 3                                   |
| 143-146 | Hemorrhage...  | 8                    | 8                                   |
| 144-148 | Toxemia.....   | 11                   | 2                                   |
| 147     | Infection..... | 20                   | 7                                   |
| 145-149 | Accidents..... | 8                    | 6                                   |
| 150     | Other.....     | 2                    | 2                                   |
|         | Total.....     | 62                   | 35                                  |

\* Two non-puerperal deaths from hemorrhage are not included.

#### COMMENT

We have made good progress this past year. If the puerperal mortality rate for 1944 had been the same as in 1943, 105 women would have died, instead of sixty-two, an actual saving of forty-three mothers' lives. Yet even a superficial glance at our experience will show that there is much more to be done. Many controllable factors have been indicated. This is not the place for discussion of the importance of good judgment, or the

fundamentals of diagnosis or the well accepted tenets of good obstetric practice. One penetrating generalization is worth more than all that.

The melancholy record of deaths from hemorrhage is proof that our securities against death from this cause are inadequate. The red torrent still inundates our statistics. Year after year it has been no different as the following table will show. (Table III.)

TABLE III  
MAJOR CAUSES OF MATERNAL DEATH, BROOKLYN 1937 TO 1944

| Year       | Infection | Toxemia | Hemorrhage |
|------------|-----------|---------|------------|
| 1937       | 27        | 26      | 29         |
| 1938       | 27        | 18      | 27         |
| 1939       | 30        | 12      | 14         |
| 1940       | 18        | 10      | 28         |
| 1941       | 10        | 8       | 20         |
| 1942       | 25        | 22      | 30         |
| 1943       | 13        | 14      | 60         |
| 1944       | 16        | 9       | 35         |
| Total..... | 166       | 119     | 243        |

In May, 1938, I reported: "We have been made acutely aware of the importance of quick transfusion. Indications for transfusion are clear. No one can take exception to them. The hospital has a very definite obligation in this matter. Responsibility for the patient's welfare does not rest entirely with the doctor. Not only do women have a right to expect the hospital to be safe, but the best interests of patient, physician and hospital are served in no other way. This responsibility cannot be shirked."

For treatment of serious obstetrical hemorrhage, blood plasma is not sufficient. The importance of blood transfusion cannot be over evaluated. Large amounts are often necessary, and the sooner blood is given, the better; and speed during its actual administration is often vital. In the emergency when veins fail, or cut-down proves time consuming or unsuccessful, sternal transfusion is safe and effective.

We should know whether the Rh factor is present in our patients or not. It is clear that hemolysis caused by the Rh factor can be prevented if every Rh negative woman receives Rh negative blood of the same type as hers. Yet these donors may not be available, and proper anti-Rh serum is difficult to obtain and the test itself, though simple, is delicate and requires expert technical interpretation. Errors are not uncommon, and it is fortunate that many Rh negative women are not easily sensitized.

However, situations will arise when the need for blood replacement is acute, and trustworthy facilities for determination of the Rh factor are not at hand. In that emergency, Wiener's<sup>5</sup> biological test for sensitivity should be performed. If the test is negative, as it is likely to be, any quantity of the same blood may be administered with safety. Group o blood will not

cause reactions if given to A, B and AB recipients unless its titer of anti-A and anti-B agglutinins is high. High titer o blood should be so labeled.

Brooklyn is a large urban center in which maternal mortality rates have differed but little from national statistical trends. In Brooklyn, hemorrhage is the most frequent and the most important cause of maternal death. The exact relation which our experience bears to the national scene is difficult to establish, yet there is good reason to believe that the situations are parallel.

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# INTRAVENOUS OBSTETRICAL ANESTHESIA\*

## PRELIMINARY REPORT

FREDERICK M. ALLEN, M.D.

NEW YORK, NEW YORK

THE small literature on the intravenous use of drugs of the procaine class will be referred to in later more complete papers. As mentioned elsewhere,<sup>1</sup> experiments on shock impressed me with the selective permeability of capillaries in injured or inflamed areas, and led to speculation whether this change might be utilized for the introduction of beneficial substances into such areas. The experience of Lundy<sup>2</sup> in relieving pruritus in several jaundice cases suggested this introduction of local anesthetics. The oligarchic suppression of the entire shock research included prevention of the desired animal experiments along this line. Progress thus became transferred to Canada, where Gordon<sup>3</sup> and McLachlin<sup>4</sup> adopted the Lundy method, respectively for painless dressings of burns and for relieving pain after surgical operations.

It therefore appeared unavoidable to venture upon clinical trials without the anticipated experimental preparation. The Lundy technic was extensively modified<sup>1</sup> as follows: (1) The quantity of procaine and strength of solution were greatly increased; (2) the time of infusion was greatly lengthened; (3) saline was replaced by glucose solution in conditions in which edema might be harmful; (4) the range of application was extended to the widest variety of painful conditions. In fact, we are still searching for any kind of severe pain which cannot be relieved by procaine intravenously. The theory still appears valid that procaine circulating in a low symptomless concentration in the blood does not produce local anesthesia in normal tissues; but in regions of injury, pain, in-

flammation or edema the increased capillary permeability allows the procaine to diffuse into the tissues and anesthetize the nerve endings there. Any cases of pain not associated with this special vascular permeability will theoretically not be relieved.

Apprehension is natural at first concerning the safety of the method. If an infusion is begun very slowly, it presumably is safer than the usual local infiltration, because with this usual method the surgeon injects practically the entire quantity at once and is unable to stop the absorption as an intravenous drip can be stopped. We make routine tests for sensitiveness, however, in every preliminary preparation by injecting a drop of 1 per cent procaine solution intradermally. If there is any doubt, after fifteen minutes a drop can also be instilled into an eye, because the conjunctival reaction can scarcely be serious if the skin test is at all questionable after this interval. Few instances of hypersensitiveness have been encountered thus far. The doses infused by vein, though unprecedentedly large, have never occasioned anything more than dizziness or other harmless subjective symptoms, often with moderate tachycardia but never with alarming changes in circulation, respiration or other functions. The dosage is judged empirically by continuous observation in each case. There is complete absence of unpleasant accompaniments or after-effects. If untoward symptoms should ever develop, antidotes are available in the form of epinephrine subcutaneously for respiratory distress or a soluble barbiturate intravenously for muscular spasms. All experience to date, however, seems to indicate that

\* From the City Hospital, Welfare Island, New York. This work was financially supported by Mr. Albert A. Volk of New York City.

danger is non-existent as long as the dosage is kept within the limits set by subjective symptoms such as giddiness, mental confusion or thick speech. The rapid destruction of procaine in the liver or elsewhere results in almost immediate clearing of symptoms when the infusion is stopped.

The obstetrical use of this method was suggested theoretically by the following considerations: (1) Caudal anesthesia with procaine is efficient in labor but requires environment and skill which are available to only a few fortunate women. (2) Labor pains originate from tissues which are edematous or congested so as probably to present the requisite increase of capillary permeability. (3) Procaine affects sensory nerves more quickly and strongly than motor nerves, therefore, it may be feasible to find a dosage which will at least reduce painful sensations while not diminishing uterine contractions.

The primary fact established by clinical experience is that labor pains can actually be alleviated in this way. The sensations are not entirely abolished within the limits of dosage mentioned, but they are reduced to a degree which makes them more easily endurable and which is very gratifying to the patient. The entire technic is still in process of development, and one of the first questions must be when to begin the treatment. Our provisional impression is that the infusion should usually not be begun in the earliest stage, especially in primiparas or any patients with mild pains, feeble uterine contractions and the prospect of long labor. The impression is that the relief of such pains may be attended by reduction of uterine contractions or even a temporary arrest of labor, so as to suggest the possibility that such infusions may be serviceable for checking threatened abortion. But in the second stage, when contractions are stronger and the suffering greater, the analgesic effect is most welcome; and here instead of delaying the birth process it seems rather to hasten it, because with the diminished suffering the voluntary muscles are used more effec-

tively. In the third stage and also during perineal repair the sensations are also evidently diminished but not with the same effectiveness. Suffering and outcries are not prevented. These results are in accord with the theoretical postulate of selective local analgesia, and they are sufficiently marked to be practically useful. The giving of a simple intravenous infusion, without danger of unpleasant accompaniments, appears to have definite value for relief of pain during a certain part of labor.

It was natural to try for more complete effects by increasing the quantities of procaine. Progress was thus made into a field which is clinically new, namely, central anesthesia with procaine. For this purpose a strong infusion is given rapidly. Dizziness and other subjective symptoms are either ignored or prevented. The typical result is that the patient passes quickly into a state in which she feels far away, is aware of events and afterward remembers most of them, can understand questions and often can answer by nodding her head; she also cooperates by bearing down with her abdominal muscles, all the more freely because she is entirely free from pain. The delivery and subsequent repairs of any degree or duration can be completed, as long as the procaine infusion is given at the proper rate. At the end the infusion is stopped, and within a couple of minutes the patient is conscious and talks rationally and cheerfully. There is no headache, nausea or other uncomfortable sequel and no harm to the child.

This ideal result has been the rule, and the only disturbance encountered in a few cases has been in the form of convulsions. Such spasms are brief; they have subsided within a minute after stopping the infusion; there have been no danger signs in pulse or respiration and no bad consequences. The difficulty seems to be not a mere overdosage. In a certain patient the convulsions may return whenever the infusion rate is increased to the point of abolishing pain. In other words, the anesthetic threshold and the convulsive threshold are nearly

identical in such cases. No known anesthetic drug can be used without precautions, and the convulsions, though harmless in the small series to date, are recognized as a serious and conceivably prohibitive handicap to the method.

Several ways of preventing this complication readily suggest themselves, including trials of other drugs of the procaine class. It is probably never necessary to allow any patient to have an outright convulsion, because close watching will detect slight muscle quivers or twitches which give warning in ample time to stop or reduce the infusion and thus prevent trouble. Most promising at present, however, is the use of the known antidote, namely, the barbiturates. These have the additional advantage of contributing somewhat to the anesthesia, and the question is whether doses of them which are small enough to be harmless to mother and child will be sufficient to prevent convulsions in predisposed patients. The details of such dosage remain to be established, but the general question seems to be answerable in the affirmative; for at least up to the present no disturbance of any kind has occurred in patients who have received the barbiturate prophylaxis.

A few selected case records will be summarized briefly as provisional illustrations of the various methods employed:

#### CASE REPORTS

**CASE 1.** *Simple procaine infusion:* G. J., a colored factory worker, aged thirty-six years, was admitted at 3 P.M. with pains at ten-minute intervals and the cervix 1 cm. dilated. Her only previous pregnancy six years ago had ended in abortion after two months. At that time she was found to have syphilis and received weekly treatments for over a year. A year later she had an operation for a Bartholin abscess. The medical examination revealed nothing abnormal; temperature 98.6°F., pulse 85, respiration 20, blood pressure 100/80. The pelvic measurements were normal; the fetus was in L.O.A. position with its heart rate 140.

Between 4 P.M. and 8 P.M., fairly strong labor

pains occurred at two-minute intervals, and the cervix became dilated to 2 cm. Injections of 100 mg. demerol and  $\frac{1}{100}$  gr. scopolamine hydrobromide were given at 6 P.M.

At 8:15 P.M. the pains continued at two-minute intervals, lasting thirty seconds, but with increased intensity so that the patient was crying loudly with them. At 8:30 P.M., infusion of 5 per cent glucose in water, containing 6 Gm. of procaine per liter, was started at a very slow rate of 0.5 cc. per minute. This very low dosage eased the pain appreciably but left the uterine contractions unchanged in time and strength. The flow was gradually accelerated to 1 cc. at 8:45 P.M. At 8:50 P.M. the pains were at one-minute intervals, lasting thirty seconds, but the pain with them was slight and easily endurable. The infusion was increased to 3 cc. per minute.

At 9 P.M. the contractions came at one-minute intervals and lasted forty-five seconds, but no pain whatever was felt with them. At 9:05 P.M. the head was visible at the vulva, and the infusion was accelerated to 10 cc. per minute. At 9:12 P.M. the baby was delivered with no pain, and the infusion was sharply slowed to 0.5 cc. per minute. Mother and child were in excellent condition. At 9:20 P.M. the placenta was expressed. At 9:30 P.M. the infusion was briefly speeded to 10 cc. per minute, allowing painless perineal repair. The infusion totalled approximately 200 cc. of solution and 1.2 Gm. of procaine in one hour.

**CASE II.** *Simple procaine infusion:* M. McD., colored, aged twenty years, 1 para, 11 gravid, entered the hospital at 10:30 A.M. after having felt pains since 7 A.M. The medical and obstetrical examinations were normal. There were mild pains every five minutes, and the cervix was 2 cm. dilated. At 11:30 A.M. the pains had become stronger, at three-minute intervals; the cervix was 3 cm. dilated and the membranes still unruptured.

Intravenous infusion of 5 per cent glucose in water, containing 8 Gm. procaine per liter, was then started at the rate of 5 cc. per minute. At 11:45 A.M. the uterine contractions were at two-minute intervals, lasting forty-five seconds, but very slight pain was experienced with them. The membranes ruptured at 11:50 A.M. The patient was placed on the delivery table, with pains lasting forty-five seconds at one-minute intervals. The slightness of the discomfort allowed the patient to use her



abdominal muscles with unusual effectiveness. As descent occurred, the infusion was speeded to 8 cc. per minute. The patient became unable to speak but could nod her head in response to questions. Delivery was completed at 12:05 P.M. The child cried promptly and was in perfect condition. The mother stated that she remembered events during the delivery but that it had been entirely painless.

CASE III. *Simple procaine infusion*: D. B., a thirty-year-old Spanish Negro housewife, para 1, gravid II, developed labor pains at 6 P.M. and entered the hospital two hours later. The medical examination and pelvic measurements were normal; tests with procaine revealed no hypersensitiveness. The fetus was in L.O.A. position, and the heart beat heard in L.L.B. was 160 per minute. Active uterine contractions occurred at five-minute intervals. Bleeding in progress required a sterile vaginal examination, which revealed blood trickling from a cervical laceration.

At 8:30 P.M. the cervix was 3 cm. dilated and the membranes intact. The fetal heart and the maternal pulse were both regular, 100 per minute. The patient manifested severe suffering with the uterine contractions which came at five-minute intervals and lasted thirty seconds.

At 9:25 P.M., intravenous infusion of 5 per cent glucose in water, containing 10 Gm. of procaine per liter, was begun at a constant rate of 5 cc. per minute. At 9:30 P.M. the fetal and maternal pulse were still regular at 100 per minute. The uterine contractions were at two-minute intervals, lasting thirty seconds and accompanied by only slight pain. The cervix was 4 cm. dilated.

At 9:35 P.M. the infusion rate was accelerated to 7 cc. per minute. Uterine contractions came at one-minute intervals and lasted forty-five seconds. The patient made very slight complaint.

At 9:40 P.M. she was placed on the delivery table and the infusion was speeded to 12 cc. per minute. At 9:42 P.M. she was unable to speak but nodded her head in answer to questions; and when told to "push down," she used her abdominal muscles with exceptional effectiveness because of the total absence of pain. Her pulse was regular and strong at 105 per minute.

At 9:55 P.M. the child was delivered in excellent condition, active and crying immedi-

ately, with no sign of sensory or motor alteration from the anesthesia. The mother was bleeding freely from a cervical tear but felt no pain during the repair. She was able to speak clearly and rationally on leaving the delivery room.

The total intravenous infusion in this case was 350 cc. of 1 per cent procaine solution, given during only one-half hour. There was the usual absence of toxic symptoms or sequels.

CASE IV. *Simple procaine infusion*: M. M., twenty-six-year-old factory worker, a colored primipara, entered the hospital at noon after having had labor pains since 1 A.M. The medical examination was negative. The procaine tests revealed no hypersensitiveness. The fetus was in L.O.A. position, and its heart heard in L.L.Q. was 130 per minute. Pelvic measurements were normal. Short labor pains occurred at ten-minute intervals.

At 1:30 P.M. pains were at five-minute intervals and lasted ten seconds. The cervix was 3 cm. dilated and the membranes intact. The fetal heart was 130 and the maternal pulse 105.

At 1:50 P.M., severe pains of ten seconds' duration were occurring at four-minute intervals. Infusion of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was begun at the rate of 1.6 cc. per minute. Although so slight and slow, this infusion dulled the labor pains so that they were readily endured.

The patient was left with this slow infusion unsupervised until 2:55 P.M., when she was placed on the delivery table. The uterine contractions were good but only slightly painful. The fetal heart was still regular at 130 per minute, and the maternal pulse was 106.

The infusion was now accelerated to 13 cc. per minute. Within two minutes the patient was unable to speak clearly, but could understand anything said to her and in particular could cooperate by the use of her abdominal muscles. At 3:10 P.M. a healthy child was born, which was active and cried immediately. Episiotomy and subsequent perineal suture were painless, according to the patient's behavior and subsequent statement. When she left the delivery room at 3:36 P.M. there was the usual clearness of consciousness and speech and absence of headache, nausea or disorientation.

The intravenous procaine infusion in this case amounted to 400 cc. of 1 per cent solution, given during approximately one and three-

fourths hours but especially during one-half hour at the close.

CASE V. *Emergency procaine infusion*: D. M., a thirty-nine-year-old white typist, 1 para, 11 gravid, entered the hospital in labor. While she was being prepared for delivery the membranes ruptured and the patient's shrieks of pain could be heard far outside the building. Intravenous infusion of a solution of 5 per cent glucose in water, containing 6 Gm. procaine per liter, was started at a rapid rate of 12 cc. per minute. Within two minutes pain was completely absent but the strong uterine contractions were unchanged. Rapid delivery was completed. The child breathed immediately and was in perfect condition. Perineal suturing then occupied about forty-five minutes. With continued procaine infusion the patient remained conscious enough to answer questions and stated that she felt no pain during the operation.

CASE VI. *Emergency procaine infusion with convulsions*: C. G., a Spanish speaking colored primipara aged twenty years, was admitted at 3:30 A.M. with a history of pains for the past ten hours. She was hurried to the delivery table, crying loudly with severe, almost continuous pains. At 3:35 A.M., intravenous infusion of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was started at the rate of 5 cc. per minute. The pulse was 115 per minute. Within one and one-half minutes the patient became entirely comfortable and began to sing. The pulse rate was increased to 130. There was no diminution of uterine contractions and the patient cooperated by bearing down.

At 4:09 A.M. episiotomy was performed painlessly, and delivery was completed at 4:12 A.M. The child was active and cried immediately. The placenta was delivered uneventfully at 4:18 A.M.

In preparation for repair, the infusion was speeded to a steady stream, with the result that a brief convulsion occurred. This ceased promptly upon stopping the infusion, before any antidote could be administered. The infusion was then resumed at a rate of 6 cc. per minute, permitting repair without pain. Just at the end, at 4:35 A.M., another convulsion occurred, which subsided within a few seconds after stopping the infusion. The patient recovered promptly as usual without after-effects. The total amount of infusion was 250

cc., or 2.5 Gm. procaine, during exactly one hour.

CASE VII. *Emergency procaine infusion with barbiturate*: F. M., a colored woman, aged twenty-one years, 111 para, was admitted at 10:45 A.M. with severe third-stage pains and was immediately placed on the delivery table. An intravenous injection of  $1\frac{1}{2}$  gr. of sodium amytal was given at once, and infusion of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was started. The uterine contractions continued unchanged but lost all their painfulness. The patient soon passed into a semiconscious state in which she could still cooperate by bearing down with her abdominal muscles. At 10:55 A.M. an active, crying baby was delivered. The birth and the subsequent repair were painless. Stopping of the infusion brought the usual quick return of consciousness with no uncomfortable sequel.

CASE VIII. *Probable retardation of labor by unduly long procaine infusion; barbiturate prophylaxis in final stage*: L. D., a twenty-one-year-old colored primipara was admitted at noon, after having felt labor pains for seven hours. The medical examination was normal except for a slight apical systolic heart murmur. Hypersensitiveness to procaine was absent. The pelvic measurements were normal, and the fetus was in R.O.A. position. The maternal temperature was 98.6°F., pulse 80, respiration 20, blood pressure 110/70, and the fetal heart rate was 132.

At 2:30 P.M., moderate pains of forty-five seconds' duration were occurring at five-minute intervals. The cervix was 2 cm. dilated. The maternal pulse was 66, respiration 20, blood pressure 100/70. The fetal heart rate was 130.

At 2:45 P.M., infusion of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was begun at the rate of only 1 cc. per minute. Besides the reduction of pain, there seemed to be a slight reduction of uterine contractions.

At 3:25 P.M. the pulse was 80, respiration 18, blood pressure 100/70, fetal heart 132. Uterine contractions occurred at two-minute intervals but lasted only fifteen seconds and were weaker than before. The infusion was slowed to 0.6 cc. per minute and the patient soon complained of moderate pains with the contractions.

At 4:50 P.M. the pulse was 80, respiration 18, blood pressure 110/70, fetal heart 132. Pains were now lasting forty-five seconds at one and

one-half minute intervals. The cervix was 3 cm. dilated. The patient complained moderately with the pains and dozed between them. The infusion was speeded to 3 cc. per minute.

At 6:30 P.M. the pulse was 80, respiration 18, blood pressure 110/70, fetal heart 132. The uterine contractions were of the same rate and duration and the cervix was 5 cm. dilated. The infusion was slowed to  $1\frac{1}{2}$  cc. per minute.

At 9 P.M. the pulse was 80, respiration 18, blood pressure 110/70, fetal heart 160. Pains occurred at one and one-half-minute intervals and lasted thirty seconds. The cervix was 4 cm. dilated. The infusion was discontinued, the amount given up to this time being 600 cc. with 6 Gm. procaine, during six and one-fourth hours.

At 12:05 A.M. the uterine contractions were three minutes apart, but strong and lasting forty-five seconds. The patient was crying and complaining bitterly. The procaine infusion was resumed at a rate of 2 cc. per minute. At 12:10 A.M., the contractions seemed unchanged but occasioned very little pain, though the patient was conscious.

At 2 A.M. the patient was placed on the delivery table. She was given  $3\frac{3}{4}$  gr. sodium amytal intravenously, and the infusion rate was increased to 5 cc. per minute. The patient became lethargic but was able to mumble her name on request. Whenever the infusion was slowed she quickly roused and complained of "terrible pains." As soon as the rapid inflow was resumed she was again quiet. Delivery was performed painlessly with episiotomy and forceps. The baby breathed immediately and showed no sign of stupor. After painless repair of the episiotomy the infusion was stopped, and within ninety seconds the patient was clearly conscious and offered to walk to her bed, if permitted. There was the usual absence of headache, nausea, disorientation or other disturbance.

In this second period the infusion amounted to almost 400 cc., with 4 Gm. procaine, during two and one-half hours. The total given was thus approximately 1 liter of solution and 10 Gm. procaine. There was some apparent retardation and weakening of labor during the long early stage, but not during the later stage of delivery.

**CASE IX.** *Slightly excessive barbiturate dosage:* L. M. A., an eighteen-year-old colored factory worker in first pregnancy, was admitted

at 5 P.M. with pains occurring at two-minute intervals and lasting thirty seconds. The cervix was 5 cm. dilated but the membranes unruptured. The medical and obstetric examinations were normal; pulse 85, respiration 24, temperature 99°F. The fetus was in L.O.A. position, with regular heart action 140 per minute.

At 8 P.M. conditions were similar, and the patient was excited and crying loudly with stronger labor pains. Infusion of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was begun at a slow rate of 0.6 cc. per minute, the tests for hypersensitiveness having been negative. The uterine contractions remained unchanged, while the painful feelings were greatly relieved but still caused some complaints. The maternal pulse was 90, with blood pressure 118/70, and the fetal heart remained at 140. A dose of 3 gr. of nembutal was given by mouth.

At 9 P.M. the maternal and fetal conditions were unchanged. The cervix was 6 cm. dilated. The painful sensations were mild.

At 10:30 P.M. the patient was placed on the delivery table. The infusion was speeded to 6 cc. per minute, and at the same time 1 gr. of sodium amytal was injected intravenously. The patient went to sleep for five minutes, while the infusion was slowed to 0.5 cc. per minute.

At 11 P.M., as the patient began to scream with severe pains, a more rapid infusion of 6 cc. per minute was resumed. The maternal pulse was accelerated to 135 per minute but other conditions were unchanged. Episiotomy was performed and the child delivered without any pain. The subsequent repair was also painless. The child did not breathe immediately but within two minutes was in normal condition. The mother had the usual quick recovery of consciousness without headache or nausea.

The total infusion was 250 cc. of solution with 2.5 Gm. procaine in three and one-half hours. The impression was that the barbiturate prophylaxis was overdone in this case, with the unnecessary combination of nembutal by mouth and amytal by vein, and it was responsible for slight retardation of labor and perhaps for the delayed breathing of the child.

**CASE X.** *Thyroid and cardiac complication:* L. C., a fifteen-year-old colored school girl, had been treated several times in other hospi-

tals, beginning in 1943, for diffuse toxic goiter. She had been admitted to the medical service of City Hospital three weeks previously for complaints of nocturnal dyspnea and precordial pain. Besides pregnancy, the essential findings were thyroid enlargement, basal metabolic rate plus 30, typical clinical hyperthyroid signs, systolic murmur at heart apex, slight enlargement of left ventricle on x-ray plates and left axis deviation in electrocardiograms. She became dissatisfied and left the hospital within a few days.

She was readmitted on the maternity service at 2 P.M. on October 11, 1945, complaining of severe labor pains which had been occurring since midnight. The pains were at five-minute intervals, lasting thirty seconds, and the cervix was 2 cm. dilated. The pelvic measurements were normal. The pulse was 112, regular, and the blood pressure 140/70. The fetus was in R.O.T. position, with heart rate 140.

The skin and ophthalmic reactions to procaine were negative. At 5 P.M., nembital 3 gr. was given by mouth. At 7 P.M. the patient was walking about, crying loudly with labor pains which occurred at three-minute intervals and lasted thirty seconds. Her pulse was 115 and the fetal heart 132. The cervix was 7 cm. dilated. Infusion of a solution of 5 per cent glucose in water, containing 10 Gm. procaine per liter, was begun at a rate of only 1.5 cc. per minute. The pains, though not abolished, were almost immediately dulled so that the patient no longer cried during them.

At 9 P.M. the patient was placed on the delivery table. One-half gr. of sodium amytal was injected intravenously. The procaine infusion was accelerated to 3 cc. per minute. The patient soon became dimly conscious so that she could barely mutter her name on request. The infusion was then slowed to 2 cc. per minute. The pulse was 125 per minute and the general appearance good. Episiotomy was performed painlessly and a normal baby delivered. The birth and the subsequent perineal suturing were entirely painless. The patient was conscious and comfortable within a few minutes after the infusion was stopped.

The amount of the infusion was 350 cc., with 3.5 Gm. procaine, in the course of two and three-fourth hours. It did not retard labor in this young primipara or introduce any difficulty with the thyroid and cardiac complications.

CASE XI. *Instrumental delivery*: A. G., a twenty-year-old white primipara, had been in the hospital two days when she began to have labor pains at 8 A.M. The medical and obstetrical examinations were normal. The temperature was 98.6°F., pulse 85, respiration 18, blood pressure 130/80. The fetus was in L.S.P. position, with heart rate 154. The usual procaine tests were negative.

At 12:30 P.M. the pains were occurring at three-minute intervals and lasting thirty seconds. The cervix was 3 cm. dilated. Infusion of 1 per cent procaine in 5 per cent glucose solution was begun at 1.3 cc. per minute. Within two minutes the previously crying patient was laughing and talking about personal matters. Slight twitching of the muscles of the left side of the face was noticed. The infusion was slowed to 0.5 cc. per minute and 1½ gr. of nembital was given by mouth. The patient laughed occasionally but was not entirely clear in consciousness. Uterine contractions were at three-minute intervals, of 45 seconds' duration, and were almost painless.

At 2 P.M. the patient was placed on the delivery table, and was given ¾ gr. of sodium amytal intravenously. The infusion rate was increased to 14 cc. per minute, and after two minutes slowed to 2 cc. per minute. The uterine contractions continued unchanged but were painless. The maternal pulse was 100, the fetal heart 160. The infusion was again speeded to 12 cc. per minute as a breech delivery was effected. There was difficulty and delay with the head, which was finally delivered by forceps. The child was feeble in crying at first, but after five minutes was in good condition.

At 2:30 P.M., with the infusion slowed to 0.3 cc. per minute, the placenta was delivered. The infusion rate was then increased to 13 cc. for the purpose of a difficult suture of the cervix, which altogether occupied two hours. The pulse remained at 105, the blood pressure 130/80. The patient felt no pain and made the usual quick recovery, so that she was able to assist herself from the delivery table to the stretcher.

CASE XII. *Instrumental delivery*: E. R., an eighteen-year-old colored primipara, entered the hospital at 8 A.M. with labor pains at ten-minute intervals, which she said had started at 9:30 the previous evening. The temperature was 98.6°F. pulse 87, respiration 23, blood

pressure 118/70. The general findings and also the procaine sensitiveness tests were negative. The fetus was in R.O.A. position, with heart rate 140.

At 8:30 A.M. pains lasting forty-five seconds were occurring at three-minute intervals. The cervix was 4 cm. dilated. The patient was given  $1\frac{1}{2}$  gr. of nembutal by mouth.

At 8:45 A.M. infusion of 5 per cent glucose solution in water, containing 10 Gm. procaine per liter, was started at the rate of 1 cc. per minute. The uterine contractions continued at the three-minute rate and lasted one minute. The maternal pulse was 85, the fetal heart 140. The painful sensations were reduced so as to be easily bearable, the patient remaining clearly conscious.

At 9:40 A.M. the patient was placed on the delivery table and the infusion was accelerated to 11 cc. per minute. The result was the usual dimming of consciousness and complete absence of pain, while strong uterine contractions of one minute's duration occurred at one-minute intervals. Sodium amytal gr.  $\frac{3}{4}$  was injected intravenously and the same rate of infusion was continued, while episiotomy was performed and a vigorous crying child delivered painlessly with forceps.

The infusion was then slowed to 0.3 cc. per minute and the placenta was delivered at 10:15 A.M.

A more liberal use of barbiturate being now unobjectionable, an injection of 2 gr. sodium amytal was given intravenously. The infusion rate was increased to 13 cc. per minute, during two hours which were occupied with suturing of the cervix and perineum. With the usual quick recovery of consciousness, the patient was able to talk while being moved from the delivery table, and there was the usual absence of after-effects.

#### SUMMARY AND CONCLUSIONS

With intravenous procaine infusions, two grades of obstetrical analgesia are obtainable, provided rare cases of hypersensitiveness are excluded by tests.

Small dosage, not sufficient to cause dizziness or other subjective symptoms, can dull the pains especially during the second stage of labor, so that they are much more easily endurable. This effect is interpreted as being wholly or chiefly on the peripheral nerves. It fails to give much

relief during third-stage delivery and subsequent repair operations. The advantages are the considerable alleviation of suffering, with convenience and complete safety.

Larger dosage, by an apparent central action, induces a state of dim consciousness in which the patient is more or less unresponsive but retains some awareness and memory of events. Touch sensations may persist but anesthesia, in the strict sense of absence of pain, can be maintained during delivery and any necessary operations.

The only difficulty encountered thus far has been the occasional liability to convulsions. These have not been disastrous and can apparently be prevented by preliminary administration of barbiturates.

The advantages are the convenient, flexible and rapidly controllable anesthesia, the non-interference with uterine contractions in the active stage, and the almost immediate recovery without headache, nausea, disorientation or other after-effects. The apparent safety for both mother and child still requires confirmation by larger experience, but the method is now routine in this hospital.

If the present hopes and indications are fulfilled, the method may furnish a solution of the immemorial problem of saving women from the pangs of childbirth.

Appreciation must be expressed especially to Dr. Kenneth Johnson, in charge of the obstetrical service, and to other staff members of the City Hospital. Without their cooperation in a surviving free institution, an independent research of this character would unquestionably have been suppressed for years, by the same control which delayed the development of surgical refrigeration and prevented its military adoption. Acknowledgment is also due to Dr. C. R. A. Gilbert, medical resident, who conducted the anesthesia in this series of cases.

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# SURGICAL MANAGEMENT OF FEMORAL VEIN THROMBOSIS\*

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THERE are five clinical forms of femoral vein thrombosis:

1. *Bland Thrombosis* of the deep veins of the calf. This is the phlebothrombosis of Homans. There is pain in the foot or calf, accompanied by local tenderness, pain in the calf on dorsiflexion of the foot (Homans' sign), slight elevation in temperature, a moderate increase in the sedimentation rate and the leucocyte count. This form is initiated in the lower leg and is the predecessor of the other thrombotic femoral processes in most instances. It has serious embolic possibilities, being non-obstructive, non-adherent and tending to propagate. It is the form for which prophylactic superficial femoral vein ligation is being extensively advocated.

2. *Acute Femoro-iliac Thrombophlebitis*. This is phlegmasia alba dolens or acute milk leg and the completely obstructing inflammatory femoro-iliac disease of Homans. It results from the propagation of a thrombus in a deep calf vein into the femoral and iliac as a completely obstructing adherent solid clot with consequent complete cessation of venous flow and marked inflammation of the vein wall. There is swelling of the leg from foot to groin, generalized pain in the extremity, local tenderness and pain in the femoral triangle, considerable elevation of temperature, increase in sedimentation rate and leucocyte count. So great is the inflammation that the surrounding lymphatics are involved in the perivenous exudate and the adjacent femoral artery is thrown into spastic contraction. Irritating impulses from the involved area cause marked

reflex peripheral vasoconstriction, increasing further the edema and vascular disturbances. Embolism is rare in this form because the thrombus is firmly adherent to the inflamed vein wall. Surgical attack is not indicated. Marked benefit is obtained by releasing the reflex peripheral vasoconstriction by paravertebral novocaine injections of the lumbar sympathetics. This form is to be distinguished from the chronic incompletely obstructing bland femoro-iliac disease described in section 4, which has dangerous embolic possibilities and which requires surgical intervention.

3. *Lower Femoral Propagating Thrombus*. A propagating thrombus from a deep vein of the calf has extended through the popliteal and dangles dangerously in the lower femoral. Although this is the state which most commonly leads to pulmonary embolism and which is amenable to simple surgical attack through femoral exploration, it is accompanied by no characteristic signs and symptoms, and we have no adequate descriptive name for it. Unfortunately, the unattached propagating mass in the popliteal or lower femoral adds nothing to the clinical picture to indicate its presence. One can only infer that such a state may exist in any case of lower leg bland thrombosis which does not quickly subside, or in any instance of pulmonary embolism. Lower femoral propagating thrombus is an urgent indication for interruption of the common femoral and should embolism have occurred, bilateral femoral division is the only safe procedure.

4. *Chronic or Subacute Femoro-iliac Bland Thrombosis*. This is the incompletely

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obstructive bland femoro-iliac thrombosis of Homans. It results from the propagation of a deep thrombosis in the calf into the

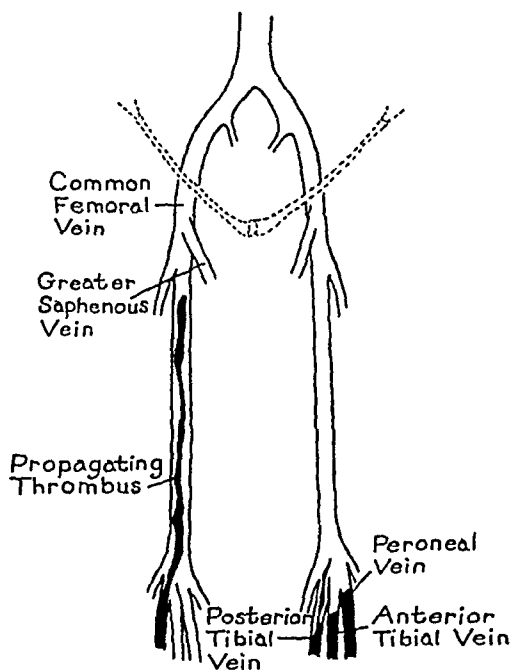


FIG. 1. Left, phlebothrombosis of the deep veins of the lower leg. The process may heal in site, propagate upward or detach and form an embolus. Right, a propagating thrombus dangles in the femoral with imminent danger of embolism. (Modified from Homans in Surg., Gynec. & Obst.)

femoral and iliac vein in the form of a non-obstructive, non-adherent clot. Whereas the site of the disease is essentially the same as that of acute femoro-iliac thrombophlebitis or milk leg, the obstructive and inflammatory factors are absent with resultant dearth of signs and symptoms and increased danger of embolism. The disease may be suspected when evidence of bland thrombosis of the deep veins has persisted unduly long (several weeks) or when embolism has occurred. According to Homans a rather characteristic sign of this advanced extensive type of bland thrombosis is lower leg cyanosis when the patient is allowed to stand up a minute or so. The cyanosis is due to extensive involvement of the collateral channels as well as to involvement of the femoral and iliac vein in the thrombotic process. In this form the profundal branch is frequently partially

thrombosed and secondary thrombosis of the saphenous or its superficial branches occurs. Other signs of bland incompletely obstructive femoro-iliac thrombosis are persistent edema, usually confined to the ankle and lower leg in the bedridden patient, and slight thickening about the femoral vessels in the groin, so that the arterial pulsation at the point is indistinct. In bland incompletely obstructive femoro-iliac thrombosis, since blood continues to flow, the proximal end of the propagating mass may readily detach, producing recurring embolic episodes. Surgical treatment has customarily consisted of extraction of the clot through the opened femoral vein. As referred to later, Homans has recently advocated attacking this form of the disease at the common iliac rather than the femoral level.

5. *Pulmonary Embolism.* This is included as a fifth clinical form of deep vein thrombosis, because the first indication of deep vein thrombosis may be, and often is, pulmonary infarction. In practically all instances, except the few cases arising from the pelvic veins or the right side of the heart, the embolus has come from deep veins of the lower extremities. Pulmonary infarction calls for immediate careful study of the legs. One may find the deep calf tenderness and slight edema of lower leg phlebothrombosis, the cyanosis, ankle edema and groin thickness of incompletely obstructive femoro-iliac disease, or the legs may be entirely normal to inspection and palpation. It is well to emphasize that the legs may show none of the usual signs and symptoms of thrombosis and yet be the source of the offending embolus. Venography has demonstrated this time and time again, and one may well convince oneself of the fact by taking venograms in a few such cases. The preferable and safest procedure is to ligate the common femoral on both sides, when pulmonary infarction has occurred, in the absence of obvious cause other than the legs. Contrarily, should inspection of the legs reveal the generalized edema and femoral tenderness

of acute femoro-iliac thrombophlebitis or milk leg, one should remember that this is usually a completely obstructive, adherent affair, and is not the likely source of the embolus. In all probability, the deep veins of the opposite leg are at fault, even in the absence of local signs and symptoms, and the femoral of the opposite leg as well as that of the clinically affected one should be surgically attacked.

#### THE COURSE OF BLAND THROMBOSIS

As practically all instances of femoral thrombosis begin in the deep veins of the calf, one may well review the subject by describing the various courses which bland thrombosis may follow: (1) The initial thrombus, having formed in the deep veins of the calf, may remain as a local process and there heal without complications or sequelae; (2) part or all of such a thrombus may become detached and form an embolus; (3) the initial thrombus may progress through the popliteal to obstruct fully the femoral and external iliac vein causing the acute obstructive inflammatory disease, phlegmasia alba dolens or milk leg, (4) the process may extend through the popliteal as a soft propagating non-adherent, non-obstructive clot floating in the lower femoral with imminent danger of embolism, and (5) the initial thrombosis may advance into the upper femoral and the iliac or even into the vena cava becoming adherent here and there to the vein wall, but complete obstruction does not occur and a current of blood persists, which may wash free the proximal end of the mass. This again is the chronic femoro-iliac bland thrombosis or incompletely obstructive femoro-iliac embolus threatening disease.

*The Rationale of Surgical Intervention.* From the foregoing, it is clear that surgical intervention in thrombotic disease of the veins of the lower extremity may hope to accomplish the following: (1) Prevent pulmonary embolism in the presence of bland thrombosis of the deep veins of the calf; (2) prevent pulmonary embolism

in the presence of the quiet, non-obstructive thrombosis in the popliteal and lower femoral; (3) prevent recurring embolic

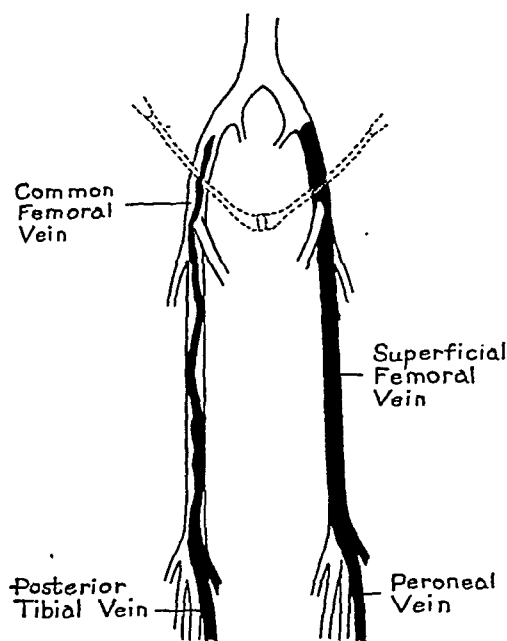


FIG. 2. Left, thrombus completely obstructs the femoral and lower iliac, causing the acute inflammatory process, phlegmasia alba dolens. Right, the thrombus has occupied the femoral and the lower iliac, but is only partly adherent and non-obstructive. This chronic or subacute form of phlebothrombosis is diagnosed with difficulty, there being only slight edema about the ankle, some cyanosis and some thickness of the vascular sheath in the groin. It is a frequent cause of embolism.

episodes when the incompletely obstructive femoro-iliac thrombotic state exists; (4) further the subsidence of acute femoro-iliac thrombophlebitis or milk leg which has not responded to conservative measures. Local extraction of the clot and local resection of a segment of the vein hasten the resolution of the process in selected instances; (5) lessen the incidence of acute femoro-iliac thrombophlebitis or milk leg by limiting the thrombotic disease to the veins below the femoral.

*Indications for Surgical Intervention.* (1) Pulmonary embolism with demonstrable signs and symptoms in the lower legs; pulmonary embolism without demonstrable signs and symptoms in the legs with positive venography evidence of deep vein thrombosis. The surgical intervention



should be bilateral in most instances. (2) Pulmonary embolism in the presence of acute phlegmasia alba dolens or milk leg.

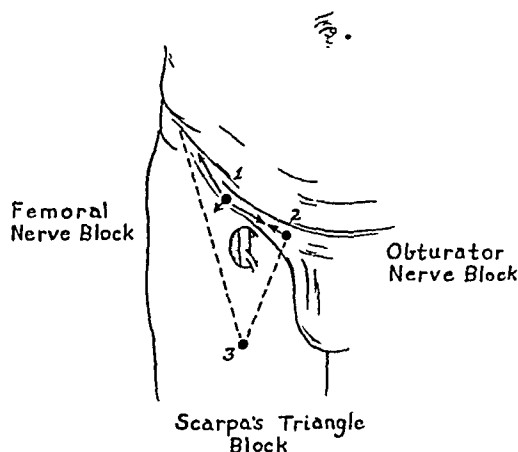


FIG. 3. Femoral vein exploration: Local anesthesia for femoral vein exploration. 1, point for femoral nerve block; 2, point for obturator nerve block; 3, apex of Scarpa's triangle.

As previously mentioned, the surgical attack is bilateral for the opposite leg may be the source of the embolus in such instances. (3) All cases of incompletely obstructive propagating lower femoral or femoro-iliac phlebothrombosis, diagnosed before or after embolism has occurred. (4) Leg amputation in the aged. Femoral vein ligation preliminary to the amputation prevents the most common cause of death in these cases.

*Bland Thrombosis of the Deep Veins of the Calf.* As we have no way of knowing which process will remain local and which will detach, ideally we should ligate the femoral in 100 per cent of such cases. And this is the practice of many clinics. However, as a certain and fairly good percentage of cases do heal *in situ* without complications, and as the age of the patient seems to be an important factor, the young being less likely to have, and better able to survive an embolism than the aged, conservatism may at times be practiced. Statistics suggest that after the age of forty the thrombus is more likely to propagate and embolism is more apt to occur. Our present practice is to interrupt the femoral vein in all instances of bland

thrombosis of the calf veins in patients over forty years of age, in all instances of bland thrombosis of the calf in patients under forty years of age which do not show signs of rapid healing, and in all instances of bland thrombosis of the calf veins in the presence of pulmonary embolism, irrespective of age.

#### OPERATIVE TECHNIC OF FEMORAL VEIN LIGATION

*Anesthesia.* Low spinal anesthesia is preferable if there are no pertinent contraindications. Local infiltration, using 1 per cent novocaine for the skin and  $\frac{1}{2}$  per cent novocaine for the deeper tissues is fairly satisfactory. Field block of Scarpa's triangle, supplemented by femoral nerve and obturator nerve block is the most effective method. The details are as follows:

*Femoral Nerve Block.* A needle is introduced 1 cm. lateral to the femoral artery just below Poupart's ligament. The needle is advanced in a direction perpendicular to the skin surface until it reaches Scarpa's fascia. It is then advanced 1 cm. deeper and as soon as parasthesia is obtained, 5 cc. of 2 per cent novocaine solution are injected.

*Obturator Nerve Block.* A wheal is raised just below and just lateral to the pubic spine. The needle is advanced perpendicular to the skin surface until it impinges on the horizontal ramus of the pubis. It is then withdrawn a little, its shaft bent inward and about 30 degrees downward and advanced until the needle point comes in contact with the upper wall of the obturator canal. The needle is then advanced outward, backward and upward about 2 cm. further into the obturator canal and about 10 cc. of 1 per cent novocaine solution are injected.

*Field Block of Scarpa's Triangle.* One-half per cent novocaine solution is infiltrated subcutaneously over Poupart's ligament from the anterosuperior spine of the ileum to the spine of the pubis, and from the apex of Scarpa's triangle upward

along the sartorius muscle laterally and the adductor muscles mesially.

**Incision.** A vertical incision is made over the femoral artery pulsation beginning just above the crease in the groin and extending downward for about 5 cm., on a line with the adductor tubercle of the femur. When the femoral pulsation is undetectable because of spastic contraction of the artery or because of thigh edema, the approximate location for the incision may be ascertained by noting the position of the femoral artery of the opposite leg.

**Procedure.** The deep landmarks are the sartorius muscle laterally, the pectineus muscle mesially, and the vascular sheath as it bisects Scarpa's triangle. No important structures are encountered until the femoral artery is reached. If the saphenous vein or its lateral superficial femoral branch is encountered, it is simply retracted mesially or laterally. The femoral artery lies anterior to and approximately on top of the femoral vein. The incision is deepened rapidly through the subcutaneous fat, through the thin Camper's fascia, more fat and then through Scarpa's fascia onto the femoral sheath. If the thrombotic process has extended into the femoral vein, the pulsation of the femoral artery may be too faint to serve as a guide for the dissection. In such instances one deepens the wound to the pectineus muscle mesially or the sartorius muscle laterally. The vascular sheath will be found just deep to the inner border of the sartorius or anterior and lateral to the pectineus.

Once the vascular sheath has been located, one may increase the length of the artery exposed by cutting freely the roof of Scarpa's triangle in the direction of the vessel. If the dissection is high in the triangle, the artery may be sufficiently lateral to the vein for one to incise the vascular sheath directly over the femoral vein. Usually the femoral vein is completely hidden by the overlying artery. It has been my practice to incise the sheath over the artery and to apply small clamps to the mesial edge of the divided sheath to

retract the artery laterally. The vascular sheath is then again incised mesially and more deeply exposing the femoral vein.

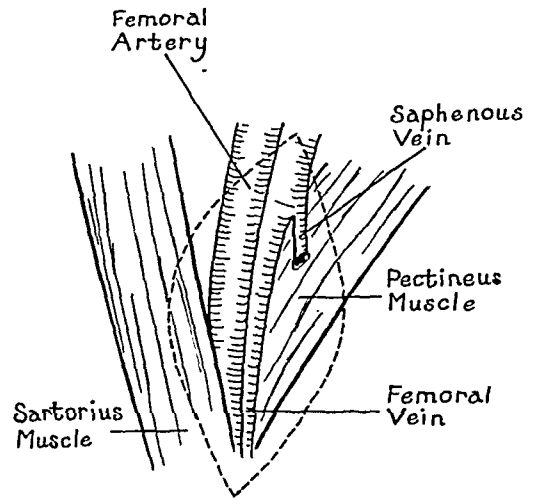


FIG. 4. Femoral vein exploration: The deep landmarks for the femoral vein exploration. In this technic the femoral arterial pulsation is the guide. No important structures exist anterior to the vascular sheath, and the dissection is directly onto the femoral artery.

The femoral vein is dissected free within its sheath from the femorosaphenous level above to the profunda branch below. Several posterior and posterolateral branches are encountered and these must be carefully ligated and divided. Premature attempts to pass an aneurysmal needle or a ligature under the femoral vein may tear one of these posterior branches or even the profunda femoris, resulting in troublesome hemorrhage.

**Approach to the Femoral Vein through the Foramen Ovale.** Instead of the above described direct dissection, the femoral vein may be approached through the foramenal ring at the femorosaphenous junction. The saphenous is dissected upward to its femoral junction. The saphenous is then divided and retracted upward to expose the foramen ovalis. A tiny, but vigorously pulsating artery, the external pudendal, is seen and divided between ligatures as it passes over the lower rim of the foramen. A curved clamp is insinuated under the foramenal rim into the femoral sheath and the rim and sheath incised. The femoral vein is thus exposed

within its compartment of the vascular sheath; there is less need for handling the artery, and less disturbance of the lym-

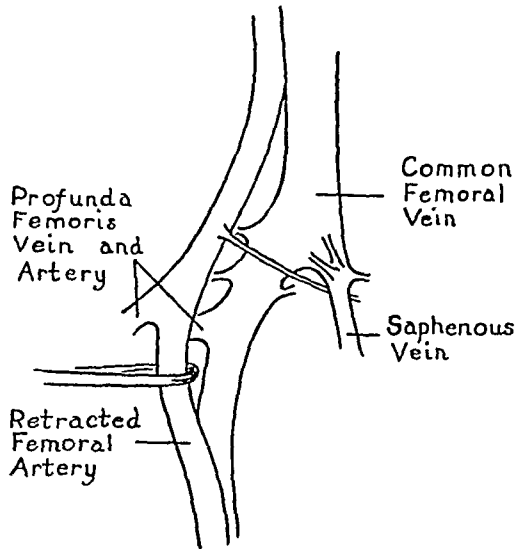


FIG. 5. Femoral vein exploration: The femoral artery must be separated from the vein and retracted laterally. The branches of the femoral vein at the site of exploration must be ligated and divided.

phatics. Although time is lost in the upward dissection of the saphenous, there is no search for the femoral vein. Furthermore, one can be sure that the femoral exploration is high—above the profunda. The needless loss of time, extra dissection, and sacrifice of the saphenous have caused me to use this approach less frequently.

*Exploration of the Femoral Vein.* Once exposed, the femoral vein may be explored between the profunda branch and the saphenous, i.e., in the common femoral or below the profunda, i.e., in the superficial femoral. The higher level is the site of election. Interruption of the vein at this level obviates any danger of embolism from an unsuspected clot in the profunda and exploration here may result in successful extraction of a clot from the upper femoral or even the iliac. However, as ligating the femoral above the profunda occasionally causes considerable thigh edema, one is justified in performing "below the profunda ligation," when the pathological process is still restricted to the lower leg, as in prophylactic ligations for

uncomplicated phlebothrombosis of the calf veins.

One might perform more "below the profunda" explorations if adequate criteria were available for determining the extent of the thrombosis. There is little about the appearance of an exposed femoral vein that indicates the state of affairs within its lumen. If the femoral artery is in a state of spastic contraction, the adjacent vein is apt to have a thrombus within its lumen; if the vein wall is altered or the vessel markedly dilated or contracted, intraluminal thrombosis probably exists. At the level of exploration, if the saphenous is divided with the head of the table elevated, absence of free flow of blood from above suggests obstruction of the femoral at a high level.

After a 3 or 4 cm. length of the femoral vein has been freed from its sheath and all pertinent branches ligated and divided, the vein is ready for exploration of its lumen. Ligatures are passed but not tied around the vein above and below the selected site of exploration and the anterior vein wall is cut open between two small clamps. The field is kept clear by suction. A swab culture of the vein lumen is made. If there is a free flow of blood from the incised femoral and no clot within its lumen, the previously placed ligatures are tied and most of the segment of vein between the ligatures is resected. Excision of a portion of the vein is important as it tends to interrupt the reflex peripheral vasoconstriction. The vein stumps are elevated to make sure no branches enter them distal to the ligatures lest postoperative bleeding occur, and additional ligatures are placed around each stump for safety.

If the lumen is completely obstructed by clot, sufficient clot must be extracted from each end to permit ligation of the collapsed vein. This condition will rarely be found as it only occurs in acute femoro-iliac thrombophlebitis or milk leg, for which condition femoral exploration is rarely performed.

If a partly organized, partly obstructing and loosely adherent thrombus is found, it may be grasped with a small stone forcep and slowly extracted from the upper femoral or even from the iliac vein. It is wise to elevate the head of the operating table during this extraction. This may prevent an unattached clot from ascending in the iliac and the downward flow of blood may even wash out through the opened vein small fragments of clot left behind during the extraction.

If the thrombus does not come out in one piece, or if the vein lumen is occupied by grumous partly clotted material, one may attempt to clear the vein by suction. The head of the table has been previously raised. A curved suction tube is inserted into the opened vein and suction applied above with the vein clamped off below. Simple glass drinking tubes, curved at the end, are suitable for this purpose. Several sizes should be available, lest the tube be too large to get into the vein lumen or too small for adequate suction. Suction should be continued at low pressure until a free flow of normal blood is obtained. The vein is then ligated above and below and a segment resected as previously described. Suction thrombectomy is most apt to be successful when the femoral exploration is performed early, before organization and adherence have had time to develop.

The above procedure is subject to certain theoretical and practical objections: The introduction of the suction tube into the upper femoral may dislodge a clot and promote embolism. One has no way of being sure the tail of the thrombus has been removed, and the operative procedure is through, rather than above the pathological process, with possibility of thrombosis recurring above the ligated segment. Such considerations have led Homans and Veal to discontinue the suction procedure. In the circumstances under discussion these authors would close the femoral triangle incision and proceed at once under general or spinal anesthesia to

explore the common iliac vein through a retroperitoneal inguinal incision.

*Closing the Wound.* As the femoral

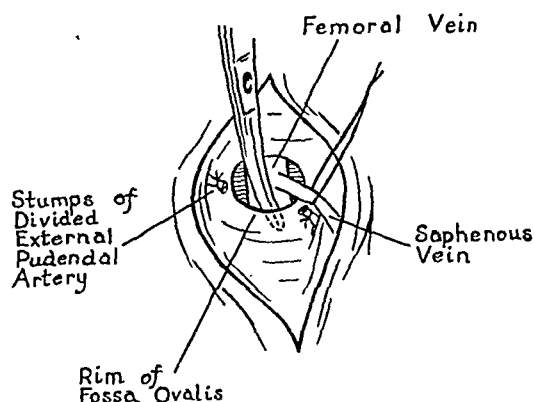


FIG. 6. Another method of approaching the femoral vein. The saphenous vein is the guide. A clamp is inserted into the vein compartment of the femoral sheath through the fossa ovalis at the femorosaphenous junction.

vein exploration has necessitated dividing lymphatic vessels which may harbor bacteria and as the vein itself may show a positive culture, I have habitually flushed the wound with 0.8 per cent sulfanilamide solution. The solution is less irritating than the powdered drug. I believe the procedure has lessened wound infection. The deep fascia and the subcutaneous fat are re-united with a few interrupted sutures and the skin closed without drainage.

#### COMMON ILIAC EXPLORATION

The disadvantages and dangers of femoral exploration in the presence of a propagating thrombus in the upper femoral have been previously described. By attacking the problem at the common iliac level, the vein may be interrupted almost invariably above the pathological process. Furthermore, as recently emphasized by Homans, when the common femoral and its collateral channels are involved in thrombosis, there is less interference with circulation from common iliac than from common femoral division. This is so because of the extensive collateral circulation provided by the hypogastric vein and its branches. However, common iliac vein exploration carries with it the added

danger of general or spinal anesthesia in critically ill patients. The retroperitoneal exposure is not easy, the dissection may be

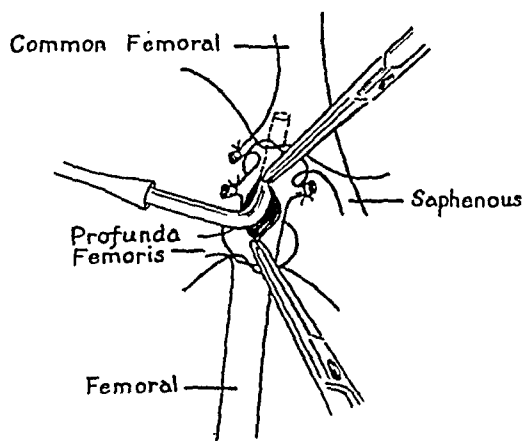


FIG. 7. Femoral vein exploration: Illustrating removal of clotted and partly clotted material from the femoral and lower iliac by suction.

through hypertrophied and infected lymphatics, with resultant danger of wound infection. There is danger of tearing the iliac vein in dissecting it free from the artery. Homans reports six right iliac sections and eight left-sided operations. Shackelford and Whitehill report a case of ligation and division of the left common iliac after extracting a soft thrombus that was propagating from the iliac into the vena cava. Common iliac exploration is performed through an oblique inguinal incision commencing in the flank and extending to the level of the external inguinal ring, parallel to the inguinal ligament. On the right side, the common iliac vein is lateral to the artery and fairly accessible. On the left side the vein is mesial and deep to the artery and extensive freeing and retracting of the artery is required to expose the vein. High dissection, exposing the vena cava is advisable and the vein section should be above the hypogastric branch.

#### POSTOPERATIVE CARE

After femoral or iliac vein exploration, measures should be instituted to limit postoperative leg edema. These include elevation of the leg on an inclined plane,

limitation of fluids, restriction of salt intake, high protein diet, warm compresses from foot to groin. Diuretics may be given by mouth or a mercurial diuretic by vein. The sulfa drugs may be ordered for a few days as a prophylactic against wound infection. Heparin and Dicoumarin may be considered if recurrence of thrombosis or extension of the thrombotic process is feared. Several days postoperatively the leg is lowered to bed level, and the patient is allowed out of bed on the sixth or seventh day. A 4 inch Ace No. 8 leg bandage should be worn until all tendency to edema is gone. The swelling is in proportion to the extent of the thrombophlebitic process rather than as the result of vein section. Section of an uninvolved femoral is followed by inappreciable edema.

#### CASE REPORTS

CASE I. P. H. Norfolk General Hospital No. 9674. Nephrectomy for pyonephrosis was performed on a twenty-six year old male. Signs of phlebothrombosis of calf veins appeared seven days postoperatively and pulmonary embolism seventeen days after onset of evidence of deep vein phlebothrombosis. Three weeks later when all signs in the leg had disappeared, a second episode of pulmonary embolism occurred. Venogram showed a filling defect in the lower femoral. At operation the femoral was explored below the profunda and found to be free of clot. "Below the profunda" ligation and resection was performed. The patient made an uneventful recovery and no further embolic episodes occurred.

*Comment.* It is unusual for a clot to detach seventeen and forty-one days after the onset of the phlebothrombosis. At the time of the femoral exploration, there was nothing about the leg to indicate it was the source of the emboli. Only the history of preceding calf pain and tenderness and the venogram gave the clue to the surgical procedure necessary to prevent further embolic episodes.

CASE II. A. R., Norfolk General Hospital No. 4697. A supravaginal hysterectomy in a thirty-five-year old woman was followed on

the tenth postoperative day by phlebothrombosis of the deep calf veins. Fourteen days later, about twenty-four hours after paravertebral novocaine injection of the lumbar sympathetics, pulmonary embolism occurred. At operation the femoral artery was a spastically contracted cord resting on top of the vein. The femoral vein was almost completely thrombosed. A red clot partially occluding the vein lumen was extracted, and a segment of vein resected between ligatures. Convalescence was uneventful.

*Comment.* Interruption of the sluggish current of blood still flowing through the partially occluded vein was beneficial in addition to the successful thrombectomy. No further embolism occurred.

CASE III. B. M., Norfolk General Hospital No. 8636. A thirty-year old female was admitted with signs and symptoms of extensive bilateral pneumonia and a violent thrombophlebitis involving the varicose right saphenous. The patient was discharged as well fifteen days later, although a patch of redness over the saphenous in the thigh was still present. The patient was re-admitted four days later with pulmonary embolism. The only sign present in the lower extremities was a dull brownish discoloration along the entire course of the previously inflamed saphenous. A venogram was interpreted as showing extensive phlebitis involving the anterior and posterior tibial and femoral vein. At operation a canalized thrombus was found forming a thin rim around the lumen of the common femoral. The common femoral was divided between ligatures. On the fourth postoperative day an episode of dyspnea and coughing occurred, and the physical signs in the chest suggested another embolic attack. Thereafter the patient made an uneventful convalescence.

*Comment.* It is well known that a latent deep vein thrombosis often co-exists with a thrombophlebitis of the saphenous system. The embolism occurring after the femoral exploration may have resulted from a clot in the femoral above the site of exploration or from the opposite leg. Bilateral femoral ligations should be performed when embolism has occurred.

CASE IV. B. J., Norfolk General Hospital No. 6570. A seventy-five-year old male was seen in consultation. His physician stated he had had clinical evidence of pulmonary embolism several days previously. The right leg was edematous from toes to groin and there was a patch of redness and tenderness on the dorsum of this edematous foot. There was a cyanotic hue to the entire leg. There were pain and tenderness in the calf of the opposite leg, and a positive Homans' sign. A diagnosis of subacute non-obstructive femoro-iliac thrombophlebitis in the right leg and phlebothrombosis of calf veins in the left leg was made. At operation the right femoral artery was spastic, and the subjacent vein filled with dark grumous partly clotted blood. The clotted and semi-clotted material was removed by suction and the vein sectioned. The left femoral vein lumen was free of pathological findings. It was likewise sectioned. The patient made an uneventful convalescence.

*Comment.* The femoral exploration was performed twenty-three days after the onset of deep vein thrombosis in the right leg. The semi-organized thrombus found at operation would suggest that the patient was in grave danger until the vein was emptied of clot and sectioned.

CASE V. A. C., Norfolk General Hospital No. 8852. The patient was first seen fifteen days subsequent to a supravaginal hysterectomy with signs and symptoms of phlebothrombosis in the left calf. Prophylactic femoral vein ligation was advised and performed. At the site of exploration in the groin the femoral vein was normal. Several days after the patient's discharge from the hospital, the signs and symptoms of pulmonary embolism suddenly occurred. The patient was re-hospitalized. Pain and tenderness in the calf and a positive Homans' sign were now present in the unoperated (right) leg. No signs were elicited in the femoral region and the thigh was not edematous. At femoral exploration an organized grayish cylindrical partly adherent thrombus was found and readily extracted *en toto*. Free flow of blood occurred from the upper vein thereafter. Convalescence was uneventful. No further emboli occurred.

*Comment.* A study of the record disclosed that this patient had a slight rise in

temperature the day of her first discharge from the hospital and complained of pain in the right calf. Bilateral deep vein involvement occurs very frequently.

**CASE VI.** M. W., Norfolk General Hospital No. 7451. Several days after her discharge from the hospital following a cholecystectomy, a forty-eight-year old female developed signs of pulmonary embolism. On re-hospitalization the left calf was tender and swollen. Symptoms and signs developed in the groin before exploration was decided upon. At exploration the common femoral contained soft, partly clotted material. This was readily removed by suction, and a good flow of blood was obtained from above. The common femoral was sectioned. The patient made an uneventful convalescence.

*Comment.* In this instance the ilio-femoral process was not completely obstructive and not completely adherent and the operative interference was probably life-saving. Some risk was taken by not likewise sectioning the femoral of the opposite leg.

**CASE VII.** B. W., Norfolk General Hospital No. 8193. A sixty-three-year old woman had a cholecystectomy and common bile duct exploration. Approximately twenty-four days postoperatively signs and symptoms developed of embolism in the right chest. Thirteen days later signs and symptoms of phlebothrombosis in the left calf were discovered. Three days later the left common femoral was explored. The vein was incompletely, but rather fully occupied by a soft red poorly organized clot. It was possible to extract all of the clot by suction, and obtain a good flow of blood from above. The common femoral was then doubly ligated and divided. The day following the operation the patient developed an episode of acute pain in the left chest which was attributed to a small embolus. From then on the patient made an uneventful recovery.

*Comment.* It is probable that the post-operative embolism which occurred the day after the femoral exploration came from a clot that was not removed from the upper femoral at the vein exploration or from a process in the deep vein of the opposite leg. It would have been safer to

have closed the groin wound and to have done a common iliac section well above the thrombotic process.

**CASE VIII.** H. L., Norfolk General Hospital No. 18254. A forty-six year old male suddenly developed pain in his right calf while apparently in good health and leading a normal life. A diagnosis of phlebothrombosis of the calf vein was made by his family physician and the patient was kept in bed and treated medically. Three weeks after the onset of his illness he suddenly developed pain in his right chest. He subsequently experienced periodic embolic episodes. The patient was sent to the Norfolk General Hospital by ambulance. There was nothing to indicate a thrombotic disease of the lower extremities but in view of the history it was decided to explore first the right femoral and subsequently the left, if necessary. Upon operation the femoral artery was contracted and spastic. Below the profunda branch the femoral vein was enormous and firm, and on opening its lumen it was found to be almost completely obstructed by greyish thrombus. Above the profunda the femoral was about normal in size and partly occluded by a reddish thrombus. There was a persistent flow of blood through the vein from the profunda branch. The common femoral was divided between ligatures after the clotted material had been removed by suction. Convalescence was uneventful.

*Comment.* A diagnosis of deep vein thrombophlebitis as the cause of the patient's embolic episode was made on information given by his family physician. At the time of the patient's hospitalization, both extremities were normal clinically. It was remarkable to see the femoral so actively involved in a thrombotic process without any local signs. In this case, apparently the flow of blood from the profunda was washing upward the thrombus as it protruded from the superficial femoral into the common femoral.

**CASE IX.** F. H., Norfolk General Hospital. A forty-nine-year old man was hospitalized because of suppuration of the soft part of the right wrist following an accident. In the third week of this illness pain and tenderness developed in the left calf and a positive Homans'

sign. Several days later the varicose saphenous vein on the right became inflamed. Subsequently signs of phlebothrombosis of the deep calf veins of this leg were elicited. The patient was treated conservatively and was discharged symptom-free about two weeks later. On his sixth day home, he suddenly experienced substernal pain, dyspnea, and anxiety. A diagnosis of a small pulmonary infarction was made. The next day a bilateral common femoral vein exploration and division were performed. The vein was normal at the site of exploration. No further embolic episodes occurred.

*Comment.* The danger of embolism in phlebothrombosis in patients over forty is again emphasized. The co-existence of superficial and deep thrombophlebitis is illustrated.

#### SUMMARY

Homans' clinical forms of femoral vein thrombosis are reviewed. Indications for surgical intervention are given. Two approaches to the femoral vein are described and details of the operative procedure in thrombotic disease given. Femoral vein ligation for prophylactic purposes in the absence of embolism is debatable. Femoral vein exploration remains the treatment of choice once embolism has occurred and there is clinical evidence of thrombosis in the deep veins of the lower extremity.

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# SIMPLIFICATION OF SPLIT SKIN GRAFTING

## GUM ACACIA TECHNIC

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THIS is a report of a method first described on February 2, 1944, at a medical meeting in the North African Theater of Operations, and since modified into its present form. The work was undertaken as a means of avoiding two serious disadvantages of the usual pressure method of skin grafting: (1) *Laborious and time-consuming suturing* and (2) marked postoperative discomfort resulting from pressure dressings.

The Padgett dermatome has simplified the cutting of a split skin graft. Our method carries simplification forward to the application of the donor skin to the recipient site. We had read of 50 per cent gum acacia as a "glue" for nerve grafts by Klemme, Woolsey and deRezende.<sup>1</sup> Stimulated by Sano's<sup>2</sup> report of successful skin grafting without sutures and pressure dressings, and made aware of the non-irritating cohesive action of 50 per cent gum acacia, we were naturally led to the method finally evolved at this hospital.

Thus far we have had the opportunity of applying the gum acacia method with increasing simplification to 210 grafts for skin defects caused by burns and trauma. These were located in various anatomical locations.

### TECHNIC

*Preparation of Gum Acacia "Glue."* Powdered gum acacia, U.S.P., is gradually added to boiling hot water until a 50 per cent colloidal solution is formed. The mucilagenous solution is autoclaved for fifteen minutes under fifteen pounds pressure.

*Recipient Site.* The grafts have taken on fascia, fat, muscle, granulation and scar tissue. The edges of a granulating wound

are usually excised to give a primary union border. Granulations may or may not be trimmed, depending upon the condition of the wound. Necrotic bases may be trimmed down to fat, fascia or muscle. Bleeding must be controlled for the graft to take. The skin area around the wound is painted with tincture merthiolate. The wound proper is never washed with any solutions.

*Donor Site.* The site is prepared by successive washes with green soap, saline and alcohol. No strong antiseptics are used. The skin is cut with the aid of the Padgett dermatome, to a thickness varying from .014 inch to .024 inch. The thicker grafts are chosen for surfaces of joints or parts which are weight-bearing or exposed to trauma. The usual donor sites have been the anterior and posterior thigh, abdomen and loin.

A pattern of the recipient site is fashioned out of muslin and outlined on the donor site with an applicator dipped in merthiolate. The outlined area of skin is washed with ether and painted with rubber cement in preparation for the cutting by the dermatome.

The donor site, after the skin graft is cut, is disposed of by a simple dressing of fine mesh gauze (usually 4 inch bandage). It is not uncovered for fifteen days. At this time it is usually found to be healed.

*Application of Graft.* The removed donor skin is not, at any time, washed or moistened. The graft is placed, raw surface down, on a flat metal sheet. Sulfanilamide powder is dusted on. The cement is wiped away with a dry sponge; the sulfanilamide powder acts as a mild abrasive. This facilitates the removal of the rubber

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FIG. 1.



FIG. 2.

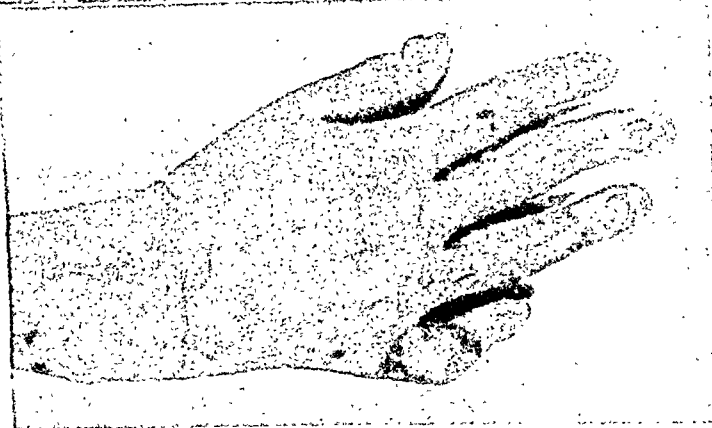


FIG. 3.

FIGS. 1, 2 and 3. Third degree burn of hand caused by fire in a tank destroyer struck by a shell. The initial treatment consisted of superficial débridement followed by vaseline gauze pressure dressing to hands. The patient was admitted to the General Hospital fifteen days after his burn. He showed third degree sloughing burns of both hands and wrists, the dorsum of his hands, and both surfaces of his wrists being involved. He was started on penicillin therapy, 25,000 units every three hours, and multiple transfusions given to restore his lowered proteins and hemoglobin to near normalcy. Twenty-three days after the burn, the hands were completely débrided, all sloughing tissue being removed surgically under general anesthesia. All dorsal tendons were either exposed or partially burned. All dorsal phalangeal joint capsules were destroyed with joints opened. The hands were put into a pressure dressing and six days after débridement, or twenty-nine days after the original burn, the patient was grafted. The split skin grafts were .022 of an inch thick and were applied with the gum acacia technic, skin clips being used to approximate the skin edges. No pressure was used, the only covering on the grafts being boric acid gauze strips to prevent drying. The hands were placed in cradles. Figure 1 shows granulating hand just prior to skin grafting. Figure 2 shows hand forty-eight hours postoperatively, clips still in and now ready to be removed. Figure 3 shows graft twenty days postoperatively. Three dermatome drumfuls had been used for this hand. Physiotherapy in form of passive motion and encouragement of active motion was started on the seventh postoperative day.

cement which remains after the separation of the skin from the drum of the dermatome.



FIG. 4. (See legend p. 305.)

Fifty per cent gum acacia is painted very thinly on the raw surface of the graft with a camel's hair brush. The layer of gum acacia is so fine that a tongue depressor scraped over the painted surface is unable to demonstrate an excess of gum acacia at the edges of the graft.

The recipient site is dried repeatedly until all oozing has ceased. The donor skin is stretched during application to the recipient site so as to reach an accurate edge-to-edge approximation. This is maintained by the use of Michel skin clips, lightly pressed. Where Michel clips are not available, they can be made by cutting diamond shaped forms out of a tin can, such as the very pliable metal container of a bottle of dried plasma. These are removed in forty-eight hours. If the graft cut is less than .010 of an inch thick, it is unnecessary to use clips, provided the graft is of the same size as the defect. We can do this because the contractability of skin .010 of an inch or less is easily overcome by the adhesiveness of the gum

acacia as adhesion begins. Where oozing may be expected, as from freshly trimmed granulation tissue, wound edges or muscle beds, we employ tiny stab holes about 4 mm. long, to allow drainage. The number and position depend on the expected degree of oozing and on the irregularity of the surface. The graft is "ironed out" with a gauze sponge to evacuate all of the blood accumulated while applying the graft. With only gentle pressure applied to the graft through dry gauze, the graft adheres to its bed over the entire area. A dressing consisting of a plain gauze pad of about four thicknesses is cut and fitted to the grafted area. Several layers of gauze are then placed over the entire area and bandages wrapped about as for any wound. Adhesive may be used as well. In all cases of grafting about the face and hands, we use no dressing at all except one layer of boric acid gauze. To protect the graft from early trauma which might dislodge it, we apply a cage fashioned from a wire ladder splint, the type commonly used in orthopedics.

*Postoperative Course.* The graft is uncovered for the removal of skin clips at the end of forty-eight hours and wet dressings of saturated boric acid solution are applied and then continued for several days. At the end of forty to forty-eight hours the graft is purplish and mottled. Mottling is more extensive in the part of the graft overlying a muscle base or any area where capillary oozing may occur in the brief period before the graft has become fixed. The color of the graft lying on granulation tissue often is a normal pink. Mottling and purplish discoloration begins to fade on the fourth day and has usually disappeared by the fourteenth day.

#### OBSERVATIONS

We have used the gum acacia method for 210 consecutive grafts during the past eleven months; fifty-four times on third degree burns and 156 times on skin defects caused by war traumas. We have had only eight failures on the grafts for burns and

ten failures of grafts for traumatic cases in spite of the fact that all wounds are grossly contaminated and many are obviously infected at the time of skin grafting.

growth of bacteria not susceptible to sulfadiazine or penicillin, such as pyocyanus, *Staphylococcus aureus*, and non-hemolytic streptococcus.



FIG. 5.

FIG. 6.

FIGS. 4, 5 and 6. Third degree burns of face. These three photographs are of the same patient as described in Figures 1 to 3. On admission fifteen days after his burn, he had sloughing granulating third degree burns of forehead, cheek, scalp, eyelids and nose. Several days of wet boric acid dressings removed slough, leaving clean granulations. Twenty-three days after his burn, at the time of the hand débridement, bilateral tarsorrhaphy was done. (Fig. 4.) Some segments of skin were present on both upper eyelids. Granulations on lower eyelids came to the edge of lids. Sixteen days later, a complete dermatome split skin graft, .020 of an inch was applied to forehead, using gum acacia as a "glue" and using several clips to hold position. Clips were removed in twenty-four hours. This is demonstrated in Figure 5 just prior to removal of skin clips. Five days later, or twenty-one days after the tarsorrhaphy, a drumfull of split skin, .010 of an inch, was laid over both eyelids and cheek in one sheet, slits having been made for lid margins. Gum acacia 50 per cent was used as the adherent; a few clips about the lateral margins of the wound were used for skin approximation. Several tiny stab holes were made along Langer's lines. Boric acid gauze strips were placed over the grafts for protection. No other covering was used. Clips were removed in twenty-four hours. Figure 6 shows patient twenty days after the last graft. Further excision and release of contractures about nose and mouth are planned for later date. Skin texture of forehead flap is excellent. It is soft, freely movable and has retained a normal color, blending in with patient's facial coloring. The skin over the eyelids is a shade or two darker than the forehead. The skin for both areas had been taken from the inner thighs. Some contractures have developed at the medial canthi; these will have to be corrected later.

Our failures occurred in those cases in which the infection advanced into frank pus formation in spite of the routine pre-operative and postoperative administration of sulfadiazine or penicillin.

These failures showed marked over-

Fifty per cent gum acacia is an excellent glue for the adhesion of a split skin graft to the recipient site. This is in part due to its high osmotic pressure which tends to absorb fluid in the vital zone of connection between graft and base. This serves a

double purpose. First, it ensures a nourished medium of body fluid bathing the graft until capillaries have grown into it.

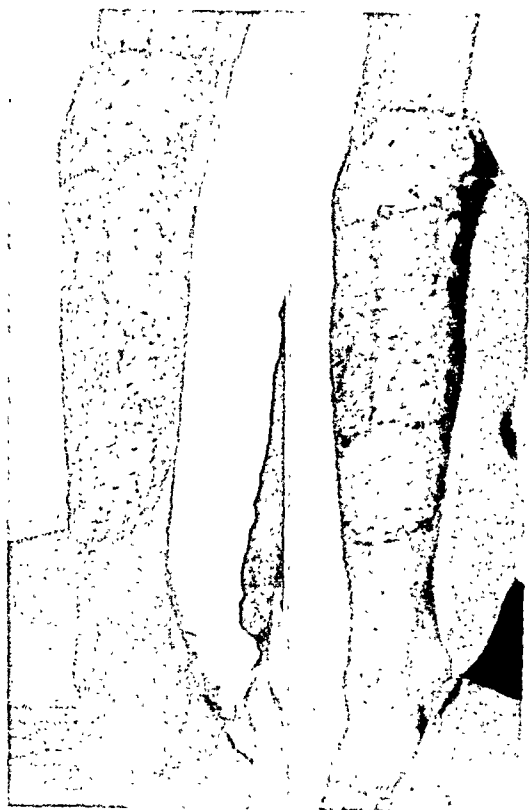


FIG. 7.

FIG. 8.

FIGS. 7 and 8. Third degree burns of thigh and leg. These photographs illustrate a third degree burn of posterior aspect of thigh and leg. The patient was admitted to the General Hospital thirty-nine days after burn, with infected necrotic slough present on infected granulations. A débridement was carried out five days later after nutrition and blood chemistry were restored to normalcy by multiple transfusions. The patient was started on 25,000 units of penicillin every three hours. Five days after the débridement three dermatome drumfuls of split skin graft .020 of an inch thick were applied to granulating surface, 50 per cent gum acacia being used as a "glue," skin clips being used for skin approximation. Boric acid gauze strip was the only covering. A protective cage was laid over the graft to protect it from trauma. Figure 7 shows the graft at the end of the third day, the clips having been removed. The graft is still mottled. Figure 8 shows the graft twenty days later. The patient is walking at this time.

Second, the fixation of plasma at the junction of the graft and wound allows the formation of dense fibrin which binds the graft securely.

The acacia is no barrier against the ingrowth of blood vessels. This is apparent from our clinical results as well as the studies of deRezende<sup>1</sup> in nerve grafts. The original dead white color of the graft changes to a purplish hue in most cases, usually within thirty-six hours. In the instances in which the grafts did not go through the purple phase, they simply changed from dead-white to pink. It is our opinion that the purple coloration may, in part, be due to the appearance of changed blood, absorbed by the gum acacia, and visible through the split skin graft.

The adherence of skin edges without the use of skin clips or sutures can be obtained by simply allowing the donor skin to be overlarge so as to allow for a contraction of the graft without tension on the edges. We prefer, however, to use an exact size graft and secure edge-to-edge approximation with the aid of skin clips. We believe that contraction of the graft delays easy penetration of blood capillaries. Furthermore, in many instances in which we have required extensive areas of skin, we have been obliged to be sparing. An exact size graft is economical compared with an overlarge graft.

Clips serve still another purpose. Since all grafts contract secondarily it has long been advised to undermine skin edges adjacent to the wound defect and when grafts are laid down to tuck the edges under in such manner as to make a redundant cuff, allowing for the contracture. The application of skin clips automatically produces this "cuff-like" arrangement desired.

Acacia as a gluing agent for skin grafting has not produced any untoward side effects sometimes associated with acacia infusions as a blood protein substitute. The quantity used in our largest graft was less than  $\frac{1}{2}$  cc.; in the average case it rarely exceeded  $\frac{1}{4}$  cc.

#### CONCLUSIONS

Split skin grafting with the aid of 50 per cent gum acacia "glue" has been

described as the simplest of the three methods we have employed: the standard "pressure-suture" technic, the "Sano coagulum" method and the "gum acacia clip"

record of grafting on unselected war wounds.

2. Fifty per cent gum acacia is available everywhere and is simple to prepare and sterilize.

3. The adhesiveness of the gum acacia permits the easy application of grafts to difficult sites, such as joint surfaces, neck, face, and irregular deep wounds.

4. Operating time has been reduced from one-half to one-third of that required by the "suture and pressure" method.

5. The use of skin clips facilitates and insures the accurate apposition of skin edges of the graft, with a minimum waste of donor skin. Removal in forty-eight hours leaves no skin marks.

6. The cosmetic value of the graft is enhanced by the absence of suture necrosis and is not impaired by the tiny stab holes.

7. The absence of a pressure dressing allows the patient to remain comfortable.

TABLE I  
ANATOMICAL DISTRIBUTION OF GRAFTS

|                        | No. Cases |
|------------------------|-----------|
| Scalp.....             | 1         |
| Ears.....              | 2         |
| Face.....              | 5         |
| Neck.....              | 3         |
| Axilla.....            | 2         |
| Arm.....               | 7         |
| Forearm.....           | 10        |
| Antecubital space..... | 7         |
| Hand.....              | 36        |
| Wrist.....             | 4         |
| Chest.....             | 4         |
| Hip.....               | 2         |
| Back.....              | 2         |
| Abdomen.....           | 2         |
| Buttock.....           | 2         |
| Thigh.....             | 43        |
| Popliteal.....         | 18        |
| Knee.....              | 4         |
| Leg.....               | 41        |
| Ankle.....             | 2         |
| Foot.....              | 11        |
| Stump, arm.....        | 1         |
| Stump, forearm.....    | 1         |

method. Of the elements and advantages of our present technique, we are stressing the following facts:

1. The successful take of 92 per cent of the grafts in 210 operations is a striking

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# CONTROL OF THE THYROID STORM\*

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ALTHOUGH the normal activity of the thyroid gland, one of the key members of the endocrine system, is probably better understood than many of its associates, much of its pathophysiology remains unknown and will have to be fathomed by future investigators. Overactivity of the thyroid, commonly called hyperthyroidism, is not clearly understood at all. At present, we realize that by surgical removal of all or most of an overactive thyroid gland we can control its hyperfunction, but we do not completely understand the mechanism behind this abnormal state of body physiology. If we did, hyperthyroidism would probably be classified among the medical and not the surgical diseases. Our dilemma regarding the pathophysiology of an overactive thyroid is multiplied a thousand-fold when we try to understand the curious state referred to as crisis. It is one of the gravest and most disconcerting complications encountered in the management of patients with hyperthyroidism. This is a condition concerning which comparatively little has appeared in the literature. When once fully developed, it is most difficult to control, in spite of the most energetic treatment and it results in a considerable number of fatalities.

In this discussion, we shall attempt to present the problem of thyroid crisis from the standpoint of control of the postoperative thyroid storm, or surgical crisis. Especially are we interested in post-thyroidectomy crisis. Medical crisis, or rampant hyperthyroidism which is the result of medical neglect and not the result of thyroidectomy, will not be considered at any length.

In reviewing the literature on post-thyroidectomy crisis, one is impressed by

the difficulty in establishing its incidence since it is not always distinguished from the so-called severe postoperative reaction. Unless the patient dies in the profound toxemia and violent and overwhelming disturbance of his metabolic processes, the surgeon often fails to classify his case as one of crisis. Hence, a recovered case is usually called one with a severe reaction to operation. Undoubtedly, many cases of crisis are never so classified in the hospital records, to say nothing of the literature.

## PHYSIOLOGY

The general physiology of the normal thyroid gland is well known to all of us. Much credit for our present knowledge must go to David Marine<sup>32</sup> for his early work along these lines. He states that the principal function of the thyroid is to increase the oxidative processes of the body. He demonstrated many of the interrelationships between the thyroid and its associate endocrine glands such as the pituitary, thymus, pancreas and adrenals. He laid down three general principles, namely, (1) the thyroid belongs ancestrally to the alimentary tract; (2) it is an organ endowed with tremendous capacities for increasing and decreasing its functional activity, as indicated by changes in weight, microscopic appearance, iodine content and blood supply; (3) hyperplasia is an index of hyperactivity but not necessarily hyperfunction. Myxedema and cretinoid states may occur in individuals and animals with typical hyperplasia.

We are all well acquainted with the rôle iodine plays as the essential element of the thyroid gland and how its administration exerts a profound effect upon the thyroid tissue. The quantity of iodine in

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the normal thyroid gland is between 2 and 3 mg. per Gm. of dried tissue.<sup>3</sup> The average total storage in the thyroid is almost 10 to 15 mg. A content below 1 mg. per Gm. of dry gland (0.5 mg. per Gm. of fresh tissue) is supposed to indicate thyroid abnormality, and in severe parathyroidism, either simple or exophthalmic, it may be as low as 0.25 mg. or less per Gm. In colloid goiters, the general level is higher. The thyroid gland, though constituting only 0.05 per cent or less of the body weight, contains about 20 per cent of the body's entire supply of iodine. Blood normally contains from 10 to 12 micrograms per cent of iodine. In hyperthyroidism it is nearer 30 micrograms per cent and in hypothyroidism between 7 to 10 micrograms. In health from 25 to 75 micrograms of iodine are excreted daily in the urine.

A glycerine extract of sheep's thyroids was first employed successfully for the relief of myxedema in 1891. The thyroid tissue itself when given by mouth was shown to be physiologically active. Bowman, in 1895, discovered that iodine was an important constituent of the thyroid extract. By means of acid hydrolysis of thyroid tissue he obtained a brownish powder containing 9.3 per cent iodine and possessing the physiological activity of the whole gland. He believed that the iodine was present in organic combination and thus called the compound iodothyron. However, it was later demonstrated that the active constituent was attached to a protein, thyroglobulin, which is the chief component of the colloid material filling the alveoli of the gland. In 1916, Kendall isolated the active principle of the thyroid in crystalline form and he called this thyroxine. In 1927, Harrington and Barger synthesized L-tyrosine and showed that it had the same pharmacologic properties as natural thyroxine.

The fundamental mechanism of action of the thyroid hormone is not known.<sup>12</sup> The site of action cannot be stated with any degree of certainty. Some men believe

that the hormone acts peripherally on the individual cells, the action being similar to that of a catalyst. Yet, if thyroxine be added to tissue slices, there is no increase in oxygen uptake. On the other hand, tissue slices taken from animals that have previously received the hormone show a definitely increased oxygen uptake. Likewise, the oxygen consumption of tissues taken from thyroidectomized animals is low.

Denervated organs *in situ* respond to thyroid as readily as organs having an intact innervation. The totally sympathectomized animal also responds to the hormone with an increased metabolic rate. There is evidence, however, that the spinal animal shows no increase in oxygen consumption after the administration of thyroid. This would indicate a central site of action. Thus, there are those who believe that thyroid acts upon the vegetative centers in the brain stem. The alleged high iodine content of the diencephalon is thought to be significant by those who adopt this point of view. Nevertheless, much work must be done before a complete understanding of thyroid physiology is available.

#### SYMPTOMATOLOGY

Before we can discuss intelligently the syndrome known as postoperative thyroid crisis, we must attempt to describe, in some fashion, the clinical picture. McQuillan<sup>34</sup> distinguishes two types of postoperative toxemia. The acute form occurs suddenly and without warning, even during the operation, and more commonly within the twenty-four to forty-eight hour period postoperatively. This is characterized by a rapid and increasing pulse rate with diminished volume and by a moderate or marked rise in temperature. In addition, there is often extreme chorea-like mental and physical restlessness, marked pallor, a dry tongue, vomiting and sometimes diarrhea. There is often a peculiar dyspnea in which the breathing is slow and sighing, and there is the complaint of pressure on the chest and the inability to take a deep



and satisfactory breath. The urine may show the presence of acetone. On the whole, the picture may resemble acute hyperinsulinism. Death may occur suddenly at any time during the progress of this group of symptoms. Lahey<sup>26</sup> believes that the earliest signs of thyroid crisis are a rising pulse rate, increased excitability, lessened emotional control and overactivation.

Less frequently, one sees the subacute variety of toxemia in which the pulse rate and temperature rise more slowly and gradually with fluctuation periods over a week or ten days. There may be occasional periods of restlessness, but this is overshadowed by stupor. Nausea and vomiting may be common and pharyngeal paralysis of varying degrees may be seen. This subacute type seems to resemble uremia and is more resistant to treatment. There seems to be no sign or symptom which will warn the attending staff that this toxemia is coming, and it is well known that such a condition may follow surgery in the patient whose preoperative thyrotoxicosis is mild as well as one with a severe type.

According to Drismore and Crile,<sup>7</sup> the acute thyroid storm is most commonly seen at its maximum severity on the second night after operation. At this time the temperature and pulse rate are markedly elevated with temperatures of 105 to 106°F. being characteristic. The patient is stimulated, restless and in very severe cases may be in such an active state of delirium that restraint is required.

#### DIFFERENTIAL DIAGNOSIS

Post-thyroidectomy crisis is rarely difficult to diagnose by an experienced house staff. Once the symptoms are evident with the extreme hyperpyrexia, sweating, flushing and restlessness and progressing toward delirium, mania and coma, there is little in differential diagnosis that is important. Hemorrhage will give a low temperature with extreme respiratory difficulty, crowing and an inspiratory tug. With atelectasis, there is more respiratory distress initially

and the physical signs in the chest are usually sufficient to establish the diagnosis. If this fails, the roentgenogram of the chest will confirm the diagnosis. Vascular accidents will usually produce localizing signs to indicate their presence, and will be accompanied by a lower temperature.

According to Fiske,<sup>8</sup> much difficulty may arise in diagnosing thyroid crisis as a postoperative complication of surgery elsewhere in the body. Here such things as internal bleeding and liver shock must be considered. However, there is good evidence to show that there is a very close relationship between liver disorders and thyroid crisis.

#### INCIDENCE

Before the days of adequate preoperative preparation of the patient with iodine, postoperative thyroid crisis was not infrequent. Greene<sup>15</sup> states that the majority of cases of crisis occur in patients in whom the hyperthyroidism has been present for a long time. Either these patients have not sought relief from their hyperthyroidism or they have had only half-hearted treatment from their attending physicians.

Nevertheless, in spite of refinements in technic in handling thyroid patients, acute postoperative crisis still accounts for many goiter deaths. Lahey<sup>24</sup> reports that his clinic had done 15,200 thyroid operations upon 13,000 patients. The mortality rate, counting all such patients who died from any cause whatever while in the hospital was 0.85 per cent. This represents a total of 111 deaths in 13,000 patients. Of this number, 40 per cent died in thyroid crisis, 10 per cent were thyrocardiacs who died in cardiac failure and 10 per cent died of emboli. The remainder died of other causes. He makes no mention of the incidence of crisis in patients who recovered, merely describing those who died. In addition, he notes that of fifty-three persons dying while awaiting operation, 33 per cent died of crisis.

Maddock, Pedersen and Collier<sup>30</sup> reviewed the cases at the University Hos-

pital in Ann Arbor, Michigan, and found that there were 123 deaths from goiter from 1925 to 1933 and that eighty-eight were due to thyroid crisis. Thirty-seven occurred postoperatively following thyroidectomy. Bayley<sup>2</sup> analyzed the deaths of the fifty-one patients who died of preoperative crisis and found that there were approximately twice as many females as there were males. In addition, he found that the average age in each sex group was 50 years.

In a recent paper, Crile<sup>6</sup> reports a series of 800 thyroidectomies in which there was no typical thyroid crisis with uncontrolled hyperthermia and soaring pulse. However, he believes that the postoperative thyroid reaction is still directly or indirectly responsible for the majority of serious postoperative complications. It paves the way for cardiac decompensation, hepatic failure and metabolic exhaustion. Interestingly enough, he reports that fatal crisis occurs 2.4 times as frequently during the hot summer months as during the rest of the year.

McGregor<sup>33</sup> in an attempt to study the geographical incidence of severe hyperthyroidism and preoperative crisis sent out a questionnaire to all of the leading goiter clinics in the United States and Canada. He found very little crisis in the East, most of the cases occurring in New Orleans, Michigan and Southern Ontario.

#### ETIOLOGY

Probably one of the least understood phases of thyroid disease is the mechanism of production of thyroid crisis. It is obviously a condition of profound toxemia and a violent and overwhelming disturbance of the metabolic processes of the body. Undoubtedly, there is a marked alteration of blood chemistry. Maddock et al.<sup>30</sup> have very aptly described our dilemma: "Metabolic processes appear to be so tremendously disturbed that some alteration in body chemistry producing the effect ought to be discoverable and ought to be measurable if only one knew what to measure."

In a rather exhaustive series of blood

studies on patients with hyperthyroidism, both preoperatively and postoperatively, Maddock studied the chief electrolytes of the blood such as sodium, potassium and phosphates. Nothing definite was found and he said, "Our search for abnormalities of inorganic iron concentrations in the blood of patients with hyperthyroidism has not been fruitful." Then they studied hepatic function in hyperthyroidism and found that their data on preoperative hepatic function gave no indication as to the mildness or severity of the postoperative course. Postoperatively, they did find an increase in the incidence and degree of impaired hepatic function and an increase in hyperthyroid reactions, but there was no evidence to show that one was the cause of the other. They admitted that a third factor could be responsible for both.

Finally, they attempted to study the relationship between the adrenals and thyroid crisis. To do this, they used the Whitehorn method for estimating the amount of epinephrine in the venous blood. The test was performed on sixteen patients with hyperthyroidism, both before and after the operation. The result was negative in five and positive in eleven. In four of the eleven, crisis developed; two died preoperatively and one postoperatively. However, they concluded that, so far, no positive identification of increased amounts of a substance which yields biologic reactions similar to those of epinephrine could be made in the blood of patients with hyperthyroidism.

In substantiating the effect of epinephrine as a factor in producing severe post-thyroidectomy reactions, Goetsch and Ritzmann<sup>10</sup> showed that the operative reactions observed in the patient with hyperthyroidism have been approximately duplicated in character and degree by a small dose of epinephrine hydrochloride administered subcutaneously to the same patient several days prior to operation. These include restlessness, hyperthermia, tachycardia and the other general characteristics of thyroid crisis. Hence, they

believe that postoperative reactions are due to increased amounts of epinephrine liberated from the adrenal glands because of the various factors which comprise the operation.

The thymus gland, because of its proximity to the thyroid gland, has attracted the attention of many workers. Many people have attempted to ascribe the death of crisis to the thymus gland. Even though the majority of patients who die of crisis have been found to have a persistent and hypertrophied thymus gland, the clinical picture of crisis does not resemble the usual thymic deaths, if such an entity really exists. Margolis<sup>31</sup> observed hyperplasia of the thymus gland in 85 per cent of the patients with exophthalmic goiter. However, he believed that the presence of a hyperplastic thymus probably represents an inherent constitutional predisposition to the development of hyperthyroidism. Thus, the relationship between a hyperplastic thymus and thyroid crisis is, at present, vague and inconclusive.

Crile<sup>5</sup> attempted to study liver failure as a factor in producing postoperative delirium in patients with hyperthyroidism. He reports an incidence of 6.5 per cent of some degree of mental confusion or delirium in 200 consecutive thyroidectomies. By doing liver function tests on these patients he found that impaired liver function was the most common single cause of postoperative confusion and delirium. However, the liver failure usually occurred on the second or third postoperative day when the postoperative thyroid reaction was subsiding. In addition, he believed that this complication of hyperthyroidism was most commonly seen in elderly patients and was more closely correlated to the age of the patient than with the height of the basal metabolic rate.

Ransom and Bayley<sup>36</sup> report the necropsy findings on fourteen of thirty-seven patients who died of crisis. In each instance the findings were of little assistance in clarifying the cause of mechanism or death. They report that the significant

findings were usually cardiac dilatation, arteriosclerosis in the older patients, frequently a persistent thymus, and occasionally an early bronchopneumonia, the latter process being altogether too early for the severe and rapidly fatal reactions. The majority of their patients dying of postoperative crisis were those who had hyperthyroidism of long standing with marked weight loss, emaciation, or those who were iodine resistant. Delay in surgical intervention as well as iodine drugging were among the most important factors in accounting for the unexpected postoperative disasters. They concluded that the necropsy findings assisted very little in understanding the exact nature of postoperative thyroid crisis. In addition, they believe that too much surgery was often the cause of severe postoperative reactions and they believe that more staged operations would reduce the mortality due to crisis. However, Foss<sup>9</sup> reports several deaths following pole ligations and even after single ligations. He agrees that the patient's condition on the operating table is rarely an index of what the postoperative period will reveal.

Kroger and Toland<sup>23</sup> report a series of twenty-seven deaths in 2,070 cases. All but two of their cases were one-staged procedures and eleven of their patients died in crisis. These men, in analyzing their deaths, believed that many of their patients could have been saved by staged operations. They also believed that the pulse rate was probably the best index of toxicity but that no code of rules could be laid down which would indicate the exact toxic state.

Foss<sup>9</sup> reports necropsy findings on twenty-nine patients who died from thyroid disease, twenty of whom died in crisis. They investigated the pathologic states of the heart, liver and thymus very carefully. There was insufficient proof to attribute the cause of death primarily to any one of these organs. They believe that the pathologist has little more to offer in deciphering the mystery of thyroid crisis

and that it remains for the physiologist and experimental pathologist to discover the true nature of the toxemia which is responsible for the death due to thyroid crisis.

There are many authorities who believe that crisis is due to a release of too much thyroid hormone or due to an exacerbation of the pre-existing thyrotoxicosis occurring postoperatively. However, McQuillan<sup>34</sup> says that it is difficult to understand how this toxemia can be due to too much normal thyroid secretion or even due to too much abnormal secretion when it occurs most often following a subtotal thyroidectomy. The remaining thyroid tissue is usually small in amount and its function is markedly impaired, at least, temporarily. Upon post-mortem examination of the thyroid tissue of such patients the alveoli show little colloid and much evidence of disintegration and destruction. All this, he believes, seems to point to the fact that the patient dies from a sudden and complete absence of the thyroid hormone, rather than from too much of it. In fact, he reports encouraging results from the subcutaneous administration of a liquid thyroid preparation in the treatment of this condition. This preparation seems to reduce the pulse rate and temperature along with an amelioration of the restlessness, delirium, nausea and vomiting.

#### ANALYSIS OF CASES

Since October, 1929, there have been 1,570 patients who had thyroidectomies at the Guthrie Clinic with three deaths due to crisis postoperatively. In all, there were twelve deaths, nine being due to other causes. All of these cases were done in one stage except twenty-three in which staged procedures were employed. A subtotal thyroidectomy, performed by the primary superior polar attack, was used throughout. Thus the incidence of crisis postoperatively is 0.19 per cent. We have seen no case of post-thyroidectomy crisis since 1934.

The average age of the patients who

developed crisis was forty-seven and all were of the female sex. All of the crisis cases were diagnosed as toxic goiters preoperatively, two being of the nodular variety. All had had goiters for many years, the average length of time being twenty-five years prior to operation. One patient had had a polar ligation sixteen years prior to thyroidectomy.

Preoperatively, all of the patients were prepared in the usual manner with Lugol's solution and adequate preparation was employed. The average preoperative hospital stay was sixteen and one-third days, the minimum fourteen days. All of the patients had elevated metabolism readings, the average being 47 per cent. However, all had shown a definite improvement in the basal metabolic rate prior to surgery. The average blood pressure was 156/83 and the average pulse rate was 87 preoperatively.

Laboratory studies in all of the patients included the usual blood chemistry and urinalysis. Only one patient showed any significant urinary findings in that she had some pus in her urine. Another patient had latent syphilis, her blood Kahn recording being 3+ and her Wassermann 4+. The average blood sugar was 135 and the blood urea nitrogen was 30.

Crisis developed on the day of operation in one patient, the day following operation in another patient and two days after operation in the third patient. Each death was the usual picture of crisis except one in whom the postoperative temperature remained around 101°F. However, her pulse rate was in the neighborhood of 160 or more. The other two patients had temperatures ranging between 104° to 106°F. and pulse rates between 145 to 180 per minute.

A postmortem examination was permitted in only one case and this patient also had a dilatation and curettage of the uterus at the time of thyroidectomy. Both at operation and at postmortem examination there was considerable pus in the lumen of the uterus, a fairly large abscess of the uterine wall being demonstrated at

autopsy. This was the woman who did not show the severe febrile response of crisis prior to her demise.

The patient who died the day of operation was one who bled rather profusely after operation and had to be returned to the operating room for further control of hemorrhage. Needless to say, hemorrhage was probably the factor which incited the severe postoperative thyroid reaction and was responsible for the crisis.

#### PROPHYLAXIS

A thyroid crisis is difficult to treat once it is established but it is relatively easy to prevent. Thus, we believe<sup>20</sup> at the Guthrie Clinic that it is more than mere coincidence or good fortune that we see so few post-thyroidectomy storms. It is our belief that the prevention of postoperative reactions begins with our first contact with the patient. These patients are nervous, suspicious and emotionally upset when first seen in the hospital or clinic. Considerable skill in meeting the patient and allaying his fears is required by the men who are in charge of the early treatment of these patients. Both the internist and surgeon should meet the thyroid patient and discuss the plan of treatment jointly soon after the diagnosis is established.

Guthrie and Woodhouse<sup>18</sup> have outlined the preoperative care of the goiter patient as practiced at the Guthrie Clinic. They state that the goiter patient needs reassurance and encouragement regarding his condition and the final outcome in his case. He should be informed as to what lies ahead of him in respect to study, preoperative therapy, and the operation. Great care is given toward treating the goiter patients individually giving vent to his eccentricities. The medical and nursing staff of the hospital realize that these patients are irritable and easily annoyed. Hence, these patients are "spoiled" in our effort to satisfy them in every way.

The period of preparation of the patient is long enough to get the patient in proper condition so that his operation may be a

safe one. Much care is used in catering to the whims of the thyroid patient. Although the average case required about ten to fourteen days of preparation, as long as six or eight weeks may be taken in severe cases if the staff believes that prolonged preparation is necessary. We never hurry our patients to the operating floor, preferring to be ultra-conservative rather than hasty in our preoperative therapy. According to Guthrie and Conklin,<sup>17</sup> rest is essential for thyrotoxic patients, and it should be both physical and mental. It is not necessary to keep these patients in bed all of the time unless they are extremely weak or in cardiac failure. They are allowed limited activity but we try to have them nap in the afternoon and sleep well at night. Sedatives are given if necessary. Iodine is administered in the form of Lugol's solution and a full, high caloric diet is prescribed. Routinely, the larynx is examined by the laryngologist to see if there is an impairment of function of the cords preoperatively. This procedure is especially of value in cases of secondary operations.

Much skill is required in determining the proper time for operation and at the clinic we rely solely upon the judgment of our internist who is a master in handling thyroid patients. He is guided by four factors: (1) The improvement of the nervous stability of the patient; (2) the improvement in and maintenance of a reduced pulse rate. This is probably the best guide he has of estimating clinical improvement of the patient; (3) a reduction in the basal metabolic rate; and (4) a definite gain in weight. This is not always present but it is reassuring when it occurs.

Once the date for operation has been selected, the patient receives a hypodermic every morning containing sterile water or morphine sulfate, gr.  $\frac{1}{8}$  (.008 Gm.).<sup>38</sup> This begins our modified anoci-association technic. A day or two prior to the operation the patient is taken to the basal metabolism room for a reading. The morning of operation the breakfast is delayed as for another

metabolism test but sodium amytal, gr. 6 (.396 Gm.) is given about one or two hours prior to the operative time. The patient goes to sleep and then receives a hypodermic of morphine sulfate, gr.  $\frac{1}{6}$  (.011 Gm.) and atropine sulfate, gr.  $\frac{1}{100}$  (.00066 Gm.) about thirty minutes before leaving for the operating room. He usually does not awake until after the operation. Since his trip to the operating room is supposed to be for another basal metabolism test, the operating room is darkened when he is wheeled in, so that he usually fails to notice any difference from the preceding day's test.

We believe the anoci-association technic is important because it prevents termination of the operation after one side is done and thereby reduces the number of staged procedures. Every surgeon who is interested in goiter patients knows that the toxic patient's pulse rate will climb to high levels as soon as he learns that he is to be operated upon. This occurs even though he is very gratified to learn that the time for surgery has arrived. With anoci-association the patient often does not know that he has been operated upon and all of his excitement over the operation has been prevented.

The operation itself is performed in such a way as to minimize trauma and thereby to prevent postoperative reactions. In the first place, a trained goiter team which acts as an efficient unit is present. The same surgeon and same assistant handle practically all of the cases. Their moves become synchronized so that lost motion and delay are at a minimum. Even the same suture nurse is used although her assistant and the intern vary from time to time.

Much difference of opinion exists among surgeons regarding the choice of anesthesia in thyroidectomies. Our choice is ethylene. This choice is corroborated by Cole.<sup>4</sup> The quiet regular respirations without the secretion of mucus most nearly approximates normal sleep.<sup>20</sup> Any abnormal traction on the recurrent nerves or on the

trachea is immediately signalled by noisy breathing on the part of the patient. We are convinced that local anesthesia has little place in thyroid surgery<sup>18</sup> with its sensation of impending suffocation for the patient during manipulation and pull on the gland. The patient's terror under local is graphically evidenced by a mounting pulse rate and a state approaching crisis when traction is applied on the gland. Lahey<sup>25</sup> prefers cyclopropane but our results are better with ethylene.

Unlike many clinics<sup>27</sup> where the decision regarding the problem of a staged operation is decided long before the day of operation, and often during the first meeting between surgeon and patient, we believe that this decision should remain until the time of operation. As a result we have had a paucity of staged procedures at the Clinic, only twenty-three in 1,570 cases, or 1.5 per cent.

We believe that much of our success in preventing postoperative reactions arises in our technic of thyroidectomy. We use the primary superior polar attack, clamping the vessels individually after they divide. We do not throw any aneurysm needles around the pole nor do we have any mass ligatures which can slip when the patient coughs.<sup>19</sup> Each vessel is visualized, clamped, and then cut. We do not attempt to expose the recurrent nerves as Lahey<sup>29</sup> does but our nerve injuries have been few. Our cases of postoperative tetany have been nil.

One of the worst complications following thyroidectomy is postoperative hemorrhage, especially that which occurs when the patient is at the height of his postoperative reaction. If it becomes necessary to take the patient to the operating room or to give him an anesthetic during this stage of his postoperative thyroid reaction in order to control hemorrhage, a severe or fatal crisis may result.<sup>27</sup> In order to prevent oozing from the remnant after the vessels have been ligated with accuracy, we roll the edge of the remnant medially and suture it to the portion which has been

intentionally left attached to the trachea.<sup>21</sup> In this way it is possible to smother bleeding from the raw surfaced remnant. Finally, by the use of fine cotton for sutures and ligatures, it has been possible for us to eliminate the use of drainage tubes in practically all of our thyroidectomies. Even when large substernal and intra-thoracic goiters are removed the resulting wounds are closed tightly without drainage. By avoiding drainage tubes it has been possible to reduce our post-thyroidectomy hospitalization from sixteen to nine days.<sup>21</sup>

Postoperatively there is much that can be done to prevent crisis. In the first place, it is advisable that toxic thyroid patients be placed in a private room postoperatively whether they are pay or charity patients.<sup>16</sup> These people require complete rest. This cannot be provided in a noisy ward full of convalescent patients. In addition, it is advisable that these patients be very closely watched by the nursing staff and attending physicians. Any untoward reaction on the part of the patient should be reported immediately to the surgeon in charge and the proper measures should be instituted without delay. The patient is especially watched for difficulty in breathing which may be due to concealed hemorrhage.

It is especially important that the junior house staff be allowed to take the responsibility for opening the wounds of patients who are bleeding. At least half a dozen lives have been saved at the Guthrie Clinic<sup>17</sup> by prompt and deliberate removal of the clips of the wound with removal of the clots in order to prevent suffocation of a patient who was bleeding. Once the wound is opened it is usually possible to take these patients back to the operating room in order to control the hemorrhage with accuracy. Bleeding patients more often die of suffocation than loss of blood.

Whether oxygen in the form of a tent or mask should be used routinely is a matter of individual preference. Crile<sup>6</sup> believes that the patient should be placed in a tent

immediately but at the Guthrie Clinic we reserve this for the bad risk patients or those whose operations have been unduly difficult. However, all of our patients are regularly ventilated with a mixture of oxygen and carbon dioxide.

Needless to say, any patient whose metabolic rate is increased needs adequate fluids postoperatively. Many of us, however, forget the rectal method of administering fluid. Routinely, all thyroid patients at the Clinic receive an enteroclysis of about 1,000 cc. of tap water as soon as they return from the operating room. In addition, they are encouraged to drink fluids by mouth if nausea is not marked.

The use of iodine postoperatively is generally employed although its action seems to be unknown. According to Crile<sup>6</sup> the administration of small amounts of iodine should be continued for at least two days postoperatively. However, he does not believe that the postoperative use of large doses of iodine exerts any striking effect upon the thyroid reaction of the patient who has received full doses of iodine preoperatively. Iodine does not act upon the tissues of the body nor upon the thyroid hormone circulating in the blood stream. It acts directly upon the secreting activity of the thyroid gland. Thus, it cannot be expected to produce any further effect upon the postoperative reaction of a fully iodized patient. Its chief benefit lies in its prevention of the symptoms incident to its withdrawal. Nevertheless, we routinely give Lugol's solution to the toxic patient postoperatively. We give m. 30 (2 cc.) in the enteroclysis immediately and then m. 8 (0.5 cc.) three times per day, by mouth, thereafter.<sup>25</sup>

#### TREATMENT—ACTIVE

Once crisis is established there is a vicious circle of hyperthermia and hyper-metabolism. Crile<sup>6</sup> reports that with each degree of elevation of temperature, there is a corresponding increase of 7.2 per cent in the basal metabolic rate. Further, with each increase in the rate of metabolism

there is a proportionate increase in the production of body heat. One of the chief problems in controlling a thyroid crisis is how to break the vicious circle of hyperthermia and hypermetabolism.

Although formerly ice bags were used, and in severe cases the patient was packed in ice, as a result of better postoperative preparation and the use of a cooled oxygen tent that is practically unnecessary now, according to Crile.<sup>6</sup> He believes that ice causes vasoconstriction of the cutaneous vessels and reduces the loss of body heat by radiation. Hence, he believes that it is more physiological to increase the loss of body heat by evaporation. To do this, he increases body perspiration by giving huge amounts of fluid. Since perspiration is directly dependent upon an adequate fluid intake, unless otherwise contraindicated, he recommends 5 to 6,000 cc. of fluid per day, intravenously, if necessary.

Aspirin promotes sweating and it is also a very efficient antipyretic in controlling the hyperthermia of crisis. Crile<sup>6</sup> reports a drop of 1 to 3 degrees F. following the administration of 10 gr. of aspirin to a patient with a temperature of 102° to 103°F. If the patient cannot swallow it by mouth, he suggests that it be given rectally in somewhat larger doses.

Patients with severe hyperthyroidism have exhausted their reserves of glycogen which are normally present in the liver. However, their increased metabolic rates require fuel for oxidation. If nausea and vomiting are present a continuous intravenous drip of 5 per cent glucose is advisable. However, since it is impossible to give more than 2,000 calories per day in the form of glucose without losing much of the glucose through the kidneys, a high caloric, high carbohydrate diet should supplement the intravenous fluid. If the patient refuses food, feedings via a nasal tube may be possible.

Morphine is an extremely valuable drug in controlling the discomfort and restlessness of patients convalescing from thyroidectomy, and especially in crisis. The

patient's tolerance to morphine seems to be in direct proportion to the degree of elevation of the basal metabolic rate. Hence, patients in crisis should receive large doses of morphine at frequent intervals unless they are very elderly. Old and debilitated patients tolerate morphine rather poorly and may be excited or severely depressed by rather small amounts of the drug. In addition to morphine, the barbiturates, bromides, or chloral hydrate may be used to quiet the patient.<sup>8</sup>

The effect of iodine in treatment post-thyroidectomy crisis in the adequately prepared patient is equivocal. Most men recommend it because it may help but its direct action is not well understood. Lahey<sup>26</sup> says, "The efficacy of iodine in the treatment of crisis will depend upon whether or not the patient has had iodine previously. If so, as good results cannot be expected as if iodine were being given for the first time." However, Goodrich<sup>11</sup> reports two cases in which there was marked postoperative crisis, one of whom was moribund. Both had failed to respond to the usual postoperative use of Lugol's solution and both improved miraculously after the use of 15 gr. of sodium iodide, given intravenously. This dose was repeated in three to four hours and every twelve hours until the storm was over. Fiske<sup>8</sup> believes that iodine should be given in liberal amounts either in the form of Lugol's or sodium iodide.

It is interesting to note a report by Rhea<sup>37</sup> in which the restlessness of a patient in crisis could not be controlled by any method other than by spinal anesthesia. Although he does not recommend this therapy for routine use, he believes that since the whole treatment of crisis is empirical, spinal anesthesia is justified when the usual methods of controlling restlessness fail.

It is obvious that until we know more about the mechanism of production of thyroid crisis and we have a thorough understanding of the complex relationships between the thyroid gland and the



other endocrines, we must be contented with our present empirical method of treating thyroid crisis.

### CONCLUSIONS

1. Thyroid crisis has been one of the chief causes of death following thyroidectomy in all clinics.

2. All surgeons agree that in the light of our present knowledge of the mechanism of crisis, our only hope of controlling the condition is to prevent it. Active therapy once crisis is established, is, at best, symptomatic and empirical.

3. At the Guthrie Clinic we employ every measure known to us in making the post-thyroidectomy reaction as mild as possible. These include long and careful preparation in the hospital with catering to the whims of the goiter patient, anoci-association, a one-staged procedure wherever possible, ethylene anesthesia and minimal trauma at operation via the primary superior polar attack method with no drainage of the wound bed. This is made possible by the use of fine cotton sutures. Postoperatively the patient is very closely watched for hemorrhage and is treated with oxygen, fluids and iodine.

4. The case reports of 1,570 patients who had thyroidectomies with three deaths due to crisis have been reviewed. Only twenty-three staged procedures demonstrates the low incidence of staged operations at the Clinic. In all, there were twelve deaths in our series, nine being due to other causes.

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*Drainage* following thyroidectomy is not necessary when all bleeding is carefully controlled. When considered necessary, a rubber tissue drain to be removed in twenty-four hours is sufficient. Rarely, excessive bleeding with impending shock may require packing of the wound and secondary closure.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# EXPERIMENTAL TRANSMISSION OF LYMPHOGRANULOMA VENEREUM VIRUS THROUGH THE PLACENTA\*

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THE venereal diseases, gonorrhea and syphilis, increase under wartime conditions. The same may be expected with lymphogranuloma venereum, which is therefore of great special interest to public health.

Moreover, lymphogranuloma venereum is a disease which, as Pollard and Hellen-dall<sup>1</sup> have lately demonstrated, can offer a very difficult task to both the obstetrician and the surgeon, by the formation of an extraordinary stricture of the rectum, resulting from the development of a big mass of perirectal connective tissue and its ulceration. Rupture of the rectum during delivery and death of the mother and the newborn child were the result.

It is known that the virus of lymphogranuloma venereum can invade the blood stream.<sup>2</sup> Therefore, it seems to be of great common interest to investigate the hitherto unanswered question if lymphogranuloma venereum is hereditary, or if it can be transmitted through the placenta to the fetus.

Since the observation of Wilhelm Frei in 1925, concerning antigen antibody relationship in lymphogranuloma venereum and the subsequent use of the specific skin test which bears his name, the disease has been found to be much more widespread than had previously been thought to be the case.

Lymphogranuloma venereum is not only a malady of the tropics, but it has also been demonstrated with almost equal frequency in the temperate zone. That this is true, may be judged from the reports which have come from the United States (Thompson), from Germany (Reiter), and

from France (Vignes). A statement has even been made by the last mentioned author that lymphogranuloma venereum is the disease of the future.

Because this virus infection has shown itself to be particularly chronic in character and destructive and debilitating in its course in women, the question of possible transmission from the mother to the newborn has assumed definite importance. In 1936, Dick, in Prague, observed a positive Frei test reaction in a fourteen-day old infant and suggested that the possible intrauterine transmission of lymphogranuloma be investigated.

In 1942, the author<sup>3</sup> published a preliminary report of an investigation dealing with the experimental transmission of the lymphogranuloma virus through the placenta of mice. Two methods of inoculation of pregnant mice were practiced: (1) subcutaneous and (2) intracerebral. In both series a fixed mouse strain of lymphogranuloma virus was injected in dilutions of 1:10. These animals were sacrificed twenty-four, forty-eight, seventy-two and ninety-six hours after the injections, or after they had gone to term and kindled. At these periods emulsions from the brains of both mother and offspring were injected into other mice. Part of the material so injected was made up into antigens in the usual manner, heating for three hours at 58°C. The antigens were then injected intradermally into human beings, and the results compared with human antigen or lygranum. Of the fifty-three human cases tested in the first report, thirty of the thirty-seven cases gave a positive reaction with the fetal antigen, while control inocu-

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lations with extracts of normal adult mouse brains were negative. Table 1 indicates that lymphogranuloma venereum was present in the brains of the embryos.

Figure 1 shows positive skin tests from a lymphogranulomatous mother animal brain and fetus brain emulsions in a human being with a positive Frei test when a total extirpation of the uterus of two pregnant mother mice had been made. I call attention to the fact that the two mother brain reactions were stronger than the fetus brain reactions.

Figure 2 shows positive skin tests four months later in the same human being from a lymphogranulomatous brain emulsion from a mother animal and its offspring, killed immediately after delivery.

The diameter of the papule of these antigen reactions has been measured with an arrow boby millimeter gauge, which dentists are accustomed to use, and which may be recommended for our purpose of measuring also.

A. W. Grace<sup>1</sup> "made easily accurate measurements with a thin, flexible scale, by intending the periphery of the papule at 90 degree intervals, with the nail of the palpating finger . . . it was his custom to take two diameters of the papule, each at right angles to the other."

Bodies similar to elementary bodies of lymphogranuloma were found in the brains of the offspring. The conclusion was reached that lymphogranuloma virus is transmitted, in the case of mice, through the placenta into the fetus. Later, there will be described a striking lymphogranulomatous skin change of the lower abdomen of a mouse, 7.5 months after delivery from an infected mother.

The present communication represents an extension of our previously published observations. The work was planned with three questions in mind: First, can we confirm our previous results with Frei tests in human beings? Second, can the initial and elementary bodies of the lymphogranuloma virus be found in the smears and tissues of the fetal brain? Third, will

antigens prepared from the brain from an intracerebrally infected mouse give a posi-



FIG. 1. Shows positive skin tests from lymphogranulomatous fetus and mother-brain emulsions in a human being with a positive Frei test, when a total extirpation of the uterus of two intravenously infected pregnant mother mice has been made. The upper papule is the reaction of emulsions of the fetus; the second is the mother-brain reaction after twenty-four hours; the third papule is the reaction of emulsions of the mother brain and the fourth shows reaction of the fetus brain after forty-eight hours; the lowest papule is the human antigen reaction on the forearm (Frei test).

tive Frei test, when injected into the skin of an apparently healthy offspring of an infected mother?

We have carried out eight experiments of inoculation into pregnant mice with six subcutaneous, one intravenous and one

in a sterile Petri dish and the fetuses were cut out in the following manner:

To eliminate the contamination with

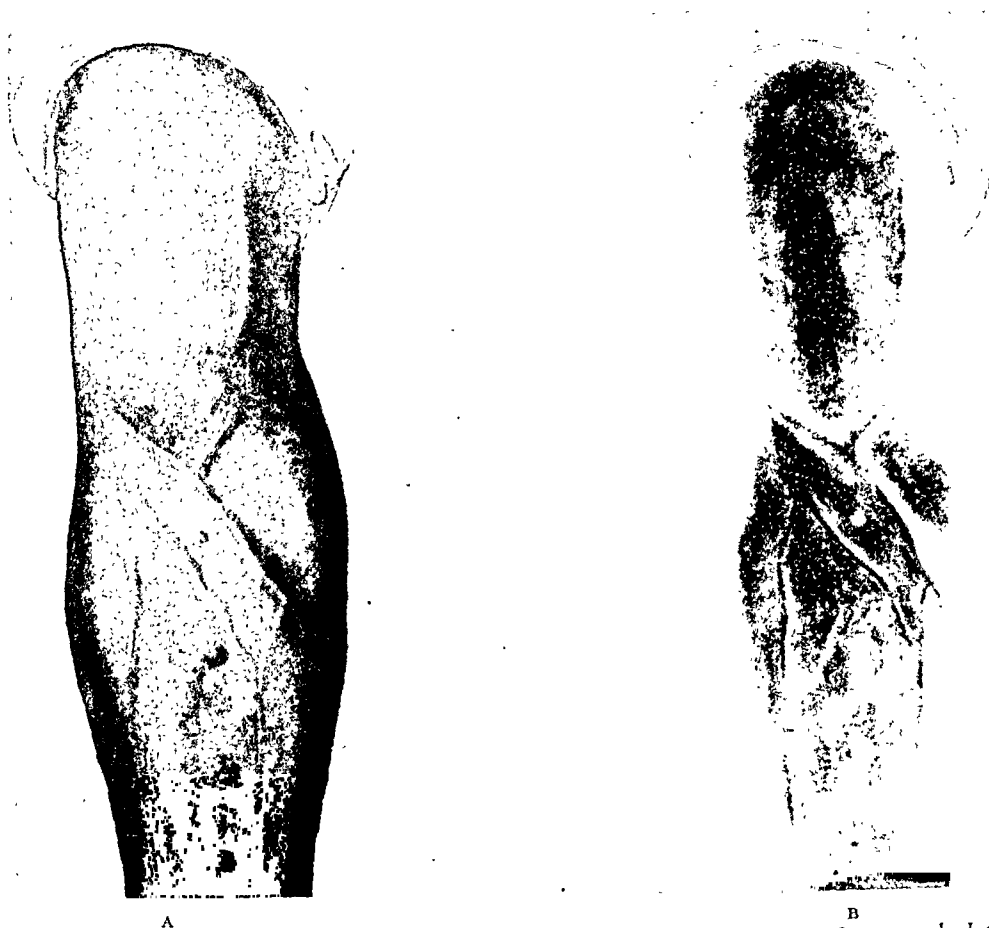


FIG. 2. Showing positive skin test from lymphogranulomatous brain emulsions four months later in the same human being as in Figure 1, from a mother animal and offspring killed a few hours after delivery when a subcutaneous injection had been made. In A, the top papule is the reaction of emulsions of a newborn brain; the second is that of a mother brain from a normal mouse; the third papule is the reactions of emulsions of a newborn brain, and the fourth is that of a mother brain from an infected mouse. A shows reaction after forty-eight hours; B shows reaction after ninety-six hours.

intracerebral injection of lymphogranuloma virus. Our whole material amounts to twenty-seven infected pregnant mice. An aseptic total extirpation of the pregnant uterus was performed in fifteen cases after infection, and deliveries occurred in twelve cases after infection. Ten extirpations and three deliveries have been published.

Total extirpation was done aseptically shortly before term, i.e., twenty-four hours, forty-eight hours and three to seven days after the infection. The uterus was placed

the mother blood from the wall of the uterus and with the maternal blood of the placenta, we removed the amnion with the fetus in it, took the fetus out and poured over the skull of the fetus 5 per cent iodine and then 75 per cent alcohol. We removed the capsule of the skull and took the brain out. Surface sterility tests and brain smears were made for microscopic examination of elementary bodies, and emulsions were made for antigens. Newborns, a few hours after delivery, have been killed and the

brains have been removed, after disinfection of the skull with 5 per cent iodine and 75 per cent alcohol.

Besides that, nineteen fetuses after an aseptic total extirpation and eight newborns, a few hours after delivery, have been thrown in Bouin-or-Zenker solution for tissue staining with hematoxylin eosin.

The nineteen fetuses, after total extirpation of the uterus, belonged to a subcutaneous, an intravenous, and an intracerebral inoculation of mother animals. The newborns belonged to three different subcutaneous experiments.

Hyperemia, hemorrhages and round-cell collections have been found in the pia mater, the plexus chorioides, and in the surface of the brains and spinal cords of the fetuses and newborns immediately after delivery. In one case of a fetus brain, eosinophiles have been seen in the meningeal exudate; in another case of a newborn, in which the animal was killed immediately after delivery nine days after inoculation, polymorphonuclear elements have been found.

From the foregoing facts, it can be concluded that a cerebrospinal meningitis has been established in the brain of the fetuses, even before delivery.

One hundred eight fetus brains, after total extirpation of the uterus, were used for antigens. In two different experiments with total extirpation of the uterus, elementary bodies were found six times, and initial bodies and elementary bodies were found five times in the smears from different transmissions of these fetus brain emulsions into the brain of mice or into the yolk-sac.

With the antigens from fetus brains after total extirpation, we had forty-one positive Frei tests with thirty-six positive fetal tests on human beings, and fourteen negative Frei tests with fourteen negative fetal tests, proving that in these cases the virus lymphogranuloma was in the brain of these fetuses before delivery. (Table 1.) On the basis of these findings, the conclu-

sion of the transmission of the lymphogranuloma virus via the placenta into the fetus of mice seems to be justified.

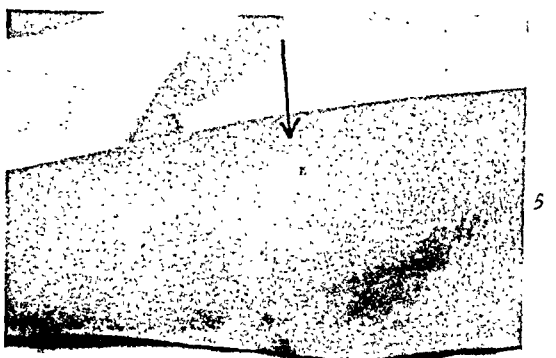
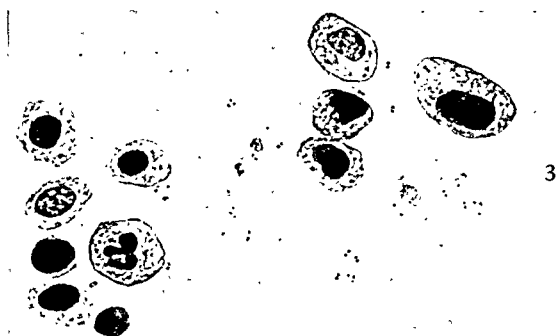


FIG. 3. Initial bodies in the brain tissue of a dead offspring after subcutaneous injection of a pregnant mouse with lymphogranuloma virus (Giemsa stain).

FIG. 4. Initial bodies in the brain smear of a sick offspring from the same experiment as in Figure 3 (Giemsa stain).

FIG. 5. A positive skin test in a lymphogranulomatous patient with emulsion from the brain of an infected offspring. The patient also gave a positive Frei test with the usual antigen.

If these fetuses had not been taken out by total extirpation but had been born, we would expect that these offspring would have had the lymphogranuloma venereum disease after delivery; and they would have shown sickness and death, elementary bodies in the brains, and positive brain tests of these offspring in human bodies with positive Frei tests.

We quote here Erich Traub:<sup>5</sup> "The detection of virus in the brains of newborn mice is regarded as an indication of in-

matous infection of the mother mouse: twenty-seven offspring in four cases were all very sleepy a few hours after delivery;

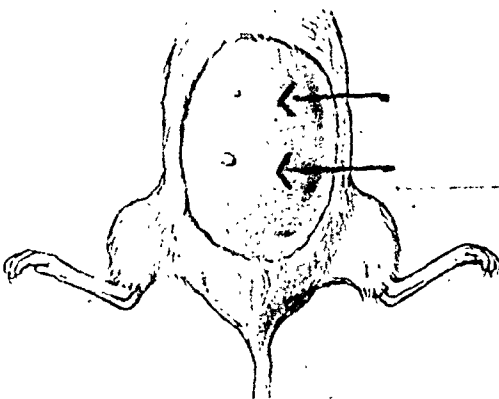


FIG. 6.

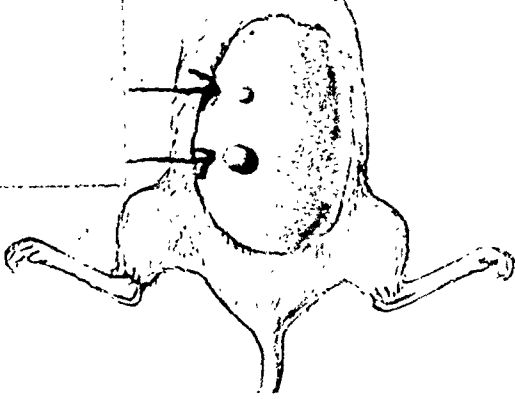


FIG. 7.

FIG. 6. The same tests as in Figure 7 in a normal mouse were negative. FIG. 7. The pupule above shows a negative test with a normal fetus brain emulsion as control. The papule below shows a positive Frei test in the abdominal wall of a male offspring from an infected lymphogranulomatous mother mouse seven and one-half months after delivery.

trauterine infection, because the time elapsing between birth and the test was too short for contact infection."

TABLE I  
ANTIGENS FROM FETUS BRAINS  
AFTER TOTAL EXTIRPATION

| Frei Tests, Positive | Fetal Tests, Positive | Fetal Tests, Negative | Frei Tests, Negative | Fetal Tests, Negative | Fetal Tests, Positive |
|----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|
| 41                   | 36                    | 5                     | 14                   | 14                    |                       |

Per cent 87.8.  
ANTIGENS FROM NEWBORNS IMMEDIATELY  
AFTER DELIVERY

| Frei Tests, Positive | New-born Tests, Positive | New-born Tests, Negative | Frei Tests, Negative | New-born Tests, Negative | New born Tests, Positive |
|----------------------|--------------------------|--------------------------|----------------------|--------------------------|--------------------------|
| 53                   | 46                       | 7                        | 18                   | 15                       | 3                        |

Per cent 86.7.

We call attention to the following data of the clinical pictures of ninety-four offspring from a total of twelve deliveries two to six days after subcutaneous lymphogranulo-

two of five offspring in one case have been found dead a few hours after delivery; they were probably born dead; three offspring in two cases were very sick forty-eight hours after delivery; one of five offspring died in another case forty-eight hours after delivery; four offspring of the same case died in three days after delivery; two of nine offspring died in another case twenty-four hours after delivery, the other seven were strikingly sleepy; four of these seven were killed forty-eight hours after delivery and three died in four weeks after delivery. One delivery happened twenty-four hours after injection with large offspring, proving that it was likely at the end of term. The delivery happened twice forty-eight hours after infection; once three, six and ten days after infection and twice four and five days after infection. Because the offspring were sick a few hours after delivery or probably dead at the time of delivery, it is to be assumed that they had acquired the disease before delivery.

The clinical picture immediately after delivery corresponds with the findings of elementary bodies in the brains of these newborns and of positive skin tests with the brain antigens of offspring.

In five of the twelve deliveries of two different subcutaneous experiments, in which the newborns were killed immediately\* after delivery, initial bodies and mostly elementary bodies were found in the smears of the brains of the newborns of four mother animals, as well as in the brains of their transmissions in mice five times, and in the yolk sac transmissions from these newborn brains twice.

In eight of twelve deliveries the newborns have been killed a few hours after delivery. Forty newborn brains were used at once\* for antigens. With the antigens from the brains of these newborns, killed immediately after delivery, we had fifty-three positive Frei tests with forty-six positive newborn tests on human beings, and eighteen negative Frei tests with fifteen negative and three positive newborn tests.

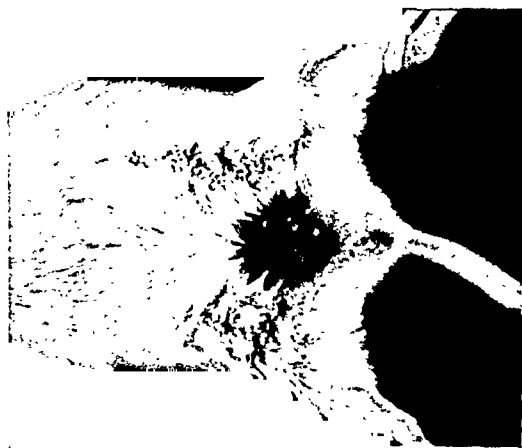
If we take a look at Table 1 we have the striking result: Antigens from fetus brains after total extirpation gave a positive fetal test in 87.8 per cent and antigens from newborn brains (at once after delivery) gave a positive offspring test in 86.7 per cent, showing almost the same result.

Tests with fetal mouse liver antigens from total extirpation of the pregnant uterus, made twenty-four hours after subcutaneous infection of the mother animal, have also been made three times in human beings. In two cases with positive Frei tests the fetal liver tests were negative; in one case of a weak positive Frei test the liver test was doubtful. Tests with new born mouse liver antigen made at once after delivery, but ninety-six hours after subcutaneous infection of the mother animal, have also been made in human beings.

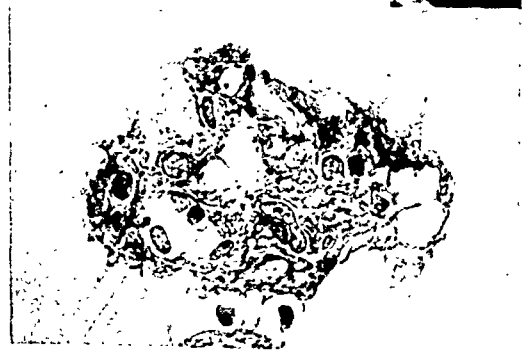
In eight cases with positive Frei tests we observed seven positive and one negative liver test. A normal liver emulsion served in five of them as a striking control. Five of the seven liver tests correspond with the newborn mouse brain tests simultaneously carried out. In two cases no newborn brain tests were made. In two cases the liver

\* The words "immediately" and "at once" are used interchangeably but both designate a few hours.

tests were stronger than the newborn brain tests. In one case, with a doubtful Frei test, the liver test was doubtful, too.



8



9

FIG. 8. A lymphogranulomatous swelling around the penis in a male offspring seven and one-half months after delivery from a lymphogranulomatous mother.

FIG. 9. Elementary bodies in the subcutaneous tissue of the skin.

In removing the liver of the fetus as well as of the newborns, respectively, we have applied the same antiseptic measures against infection as described above.

The difference in the two groups may be dependent upon the time after infection. If the virus has been developed in the body of the pregnant mouse ninety-six hours after infection, as in the first place, the effect of the antigen on the human body may be much stronger than if the time of development was only twenty-four hours after infection, as in the second place.

Because the liver of the fetus is nearer to the maternal blood by way of the vena umbilicalis than the brain of the fetus, it may be that the virus may develop earlier



in the liver than in the more distant fetal brain during the fetal circulation.

It has been shown that newborn mice,

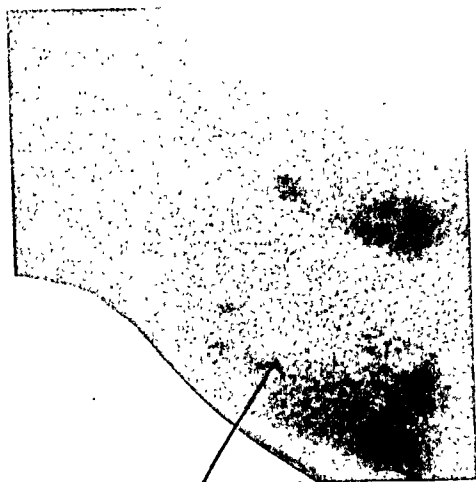


FIG. 10. A positive test of this skin material in a patient with lymphogranuloma. There was also a positive Frei test in this patient.

after lymphogranulomatous infection of a pregnant mouse, not only were very sick immediately after birth but also demonstrated at once a number of tests characteristic of lymphogranuloma venereum.

The conclusion is, therefore, justified that the lymphogranuloma virus had been transmitted via placenta to the newborn before delivery, a result which we have reached already by investigation of the fetus in the uterus by total extirpation of the pregnant uterus after lymphogranulomatous infection of the mother animal.

If that is correct, the conclusion is also justified that four offspring of another experiment of the same kind which were killed for lymphogranulomatous tests forty-eight hours after delivery and five days after infection of the mother animal, were also born with the lymphogranuloma virus in them.

Summarizing, (1) the clinical picture of the other offspring of the same delivery had shown nine sleepy newborns at the delivery; death of one newborn twenty-four hours and of one forty-eight hours after delivery and death of the other four weeks later. (2) The skin tests with the offspring

antigen and their two transmissions were positive in two cases with positive Frei tests. (3) The brain smears showed initial bodies. (Fig. 2.) (4) The clinical picture of the intracerebral transmissions I, II, and III in other mice showed sickness and death.

We are entitled to the same assumption that offspring from another delivery forty-eight hours after infection in the same experiment in which all three offspring died shortly after delivery, the last one three days after delivery, which showed initial bodies in the brain tissue of this offspring, have been born with the lymphogranulomatous virus in them.

The method used in the previous experiments was modified in that the virus used for the inoculation of pregnant mice was grown in the yolk sac of chick embryos. I shall describe one of the several experiments, all of which gave approximately the same results. Three pregnant mice received subcutaneously 0.5 cc. of a 1:10 lymphogranulomatous venereum egg yolk emulsion. Animal No. 1 was delivered 120 hours after the injection, but had killed and eaten the young mice within forty-eight hours. Animal No. 2 was delivered seventy-two hours after the injection, and mouse No. 3 was delivered ninety-nine hours after the injection. The young of Nos. 2 and 3 survived.

A brain emulsion of one of the litter from No. 2 was made forty-eight hours after delivery, and similar emulsions were made from the two young mice from No. 3 four days after delivery. The emulsions were injected intracerebrally into twenty-one mice. Of these seven mice died spontaneously from two to six days after inoculation; five became ill and were killed to obtain material for further transmissions. Antigens from the young mice of this experiment were injected into nine human cases of lymphogranuloma venereum and controlled by the usual Frei tests. Nine positive Frei tests and eight positive mice reactions were obtained. In one lymphogranuloma case there was a positive Frei test and a negative mouse test. In one

other case with a negative Frei test there was a negative mouse test.

In another experiment two pregnant mice were injected subcutaneously. Five living mice were born to one forty-eight hours after inoculation but all died three days after delivery. A photograph of a drawing of the brain tissue of the last offspring, stained with Giemsa (Fig. 3), shows the initial bodies which were present. The other pregnant mouse gave birth to nine living but strikingly sleepy, drowsy young offspring, five days after the subcutaneous injection, but two were dead at the end of forty-eight hours. The other seven appeared drowsy, and three died four weeks later. Initial bodies were found in the brain of one drowsy young mouse which was killed forty-eight hours after delivery. (Fig. 4.) An antigen prepared from the brain of this last mouse gave a positive reaction (Fig. 5) in a human case who had previously given a positive Frei test, and a negative reaction in an individual who previously gave a negative Frei test.

Rake and his collaborators<sup>6</sup> have recommended the use of the yolk sac of the chick to establish the presence of the elementary bodies. It was possible for me to show that initial bodies and elementary bodies increase in the yolk sac following the inoculation of lymphogranuloma mouse brain emulsion.

A lymphogranuloma mouse brain emulsion was passed twice intracerebrally. (Tr. 1 and Tr. 2.)\* The mouse brain emulsion from the second transfer was inoculated into two eggs and both embryos were dead after forty-eight hours. The yolk sac emulsion (1:4) was injected subcutaneously into six pregnant mice. Only two of the deliveries are reported briefly here: one twenty-four hours after injection, another six days after the injection. A Frei test on the abdomen of a male mouse from this last delivery with 0.05 cc. of injected material was made on June 9, 1943, and was positive after forty-eight hours. It caused a large papule with a diameter of

6 mm. (Fig. 7) while the control papule was only 3 mm. in diameter. (Fig. 6.) Three other characteristic reactions were observed in mice of the same delivery. Two papules suggestive of a positive Frei reaction were obtained. The antigen papule measured 5 mm. and the control tests measured between 1 to 2 mm.

From the first delivery which occurred twenty-four hours after inoculation of the mother, five living mice were born, one of which died forty-one days later. The remaining four were ill on the fifty-first day, but did not die. One of these male mice showed an area without any hair, about 1 cm. in diameter, around the swollen penis, and three nodules with infiltration of the skin to the left of the penis. (Fig. 8.) The swelling was excised and one-half used for microscopic examination and the other half to make an antigen.

The microscopic examination of excised tissue showed chronic induration and hyalinization of the subcutaneous connective tissue with infiltrates of plasma cells, polymorphonuclear cells and eosinophiles. Cellular infiltrations of the wall of the vessels and hyalinization of the adventitia of the smaller vessels were occasionally found. No bacteria were found in sections of the tissue stained with methylene blue, Brown stain, or Gram stain; but elementary bodies were found in the subcutaneous tissue by the use of Giemsa stain. (Fig. 9.) An antigen from the skin gave a positive skin test in a single human lymphogranulomatous patient (diameter 9 mm.). (Fig. 10.) With material from the same mouse skin another positive test (diameter 6 mm.), with a fairly large papule, has been obtained in a new human case with a large lymphogranulomatous swelling in the right inguinal region. This patient also gave a strong Frei test (diameter 9 mm.) with a human antigen, while the control was negative.

If offspring in a later stage after delivery show lymphogranulomatous symptoms after evidence has been shown of congenital lymphogranulomatosis in other

\* Tr—transmission.

offspring of the same, or other experiments of the same kind, the assumption seems to be clinically obvious that these lymphogranulomatous symptoms of the disease come also from a transmission of the virus through the placenta.

In five of six pregnant mice of a subcutaneous experiment, sufficient evidence for the transmission of the lymphogranulomatous virus through the placenta could be given. Of the sixth animal, five living offspring were born twenty-four hours after inoculation. One was dead after forty-one days; one was killed after five months. Transmissions in four mice were positive; one Frei test with Tr. 1 was negative.

Three offspring were still living seven months later. One mouse demonstrated a positive Frei test on its abdomen after eight months. One skin test from the swelling around the penis of a second of these offspring was twice strongly positive seven and one-half months after delivery.

We cannot exclude the possibility of the infection of these offspring by contact with the nasal secretions, the urine of the mother animal, and the maternal blood of the placenta. The port of entry of virus appears to be the nasal mucosa rather than the gastrointestinal tract. The question of contact infection by sucking of the mother's milk should be investigated, and we have already begun to do this. The fact that the milk-sucking in mice is ordinarily unsuccessful before the fifth or sixth day after delivery seems to be important.

Larger animals should be investigated to see if the amnion is permeable for the lymphogranuloma virus.<sup>7</sup> If that could be answered in the affirmative, a contact infection already in the cavity of the amnion before delivery could also be possible.<sup>7</sup>

The assumption that a number of fetuses during their intra-uterine living with lymphogranuloma virus were free of virus could be proven only when all the tests in certain offspring, tested separately immediately after delivery, were negative. That should still be done in other experiments with lymphogranuloma virus.

#### IS THE VIRUS OF LYMPHOGRANULOMA VENEREUM PERSISTENT?

W. Frei,<sup>8</sup> in his last article entitled "Combating Lymphogranuloma Venereum," which appeared in June, 1943, shortly after his death, summarizes as follows: "The question, whether in lymphogranuloma venereum persistence of positive reactions to cutaneous tests after recovery is due to a persistence of the virus, has not been decided yet, and should be investigated." And he gives a number of suggestions for research in this direction. To this research belongs the question of the importance of the Frei test in the child.

The same question arose in the course of our experimental work in the transmission of this virus through the placenta of mice especially during the study of offspring from the second and third delivery of the same infected mother mouse.

In a previous article<sup>3</sup> sufficient evidence was given of the experimental transmission of the lymphogranuloma virus through the placenta into the fetus of mice. A mother mouse had delivered twelve living offspring six days after subcutaneous inoculation with lymphogranuloma virus. Eight were killed a few hours after delivery, and brain emulsions, etc., were made. The offspring tests were twelve times positive in fourteen cases, when a positive Frei test was made. In three other cases with negative Frei tests, there were two negative offspring tests and one positive. Therefore, because the killing had been done immediately after delivery, the lymphogranulomatous virus must have been transmitted through the placenta. This originally infected pregnant mouse in the experiment conducted in October, 1942, had a total of three deliveries, and one female offspring of its first delivery also had three deliveries.

Now this question must be answered: Whether similar results could be established with offspring antigens from the *second* and *third* deliveries of this same mother mouse and the one female offspring,

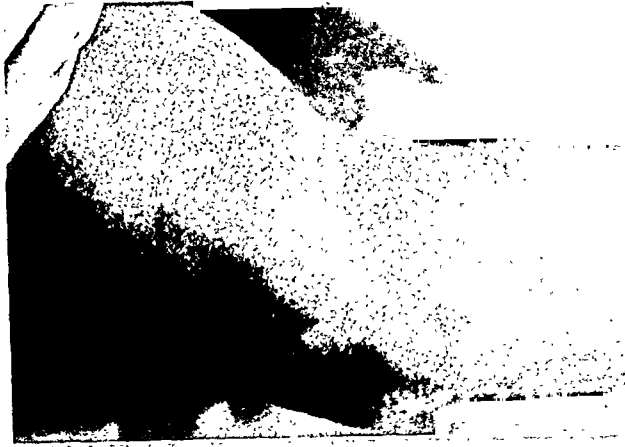


FIG. 11.

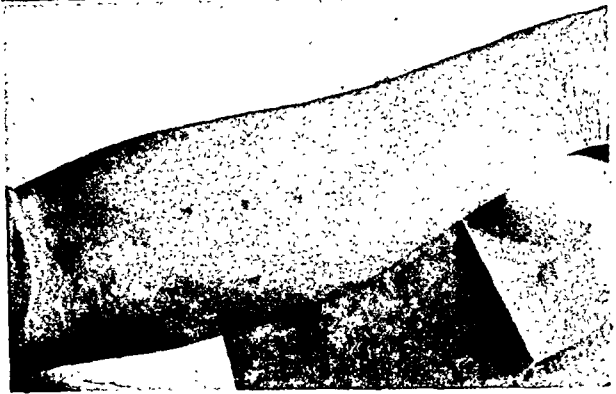


FIG. 12.



FIG. 13.

FIGS. 11 to 13. Show positive offspring tests from offspring brain emulsions of mother animal, second delivery. In Figures 11 and 12, starting from the left, the one papule is the control; the two papules following are the reactions. In Figure 13 the upper papule is the control; the lower two are the reactions.

which also had three deliveries during this period.

On January 6, 1943, the same mother

We have made thirty-eight tests on human beings with offspring antigens from the second and third deliveries of the

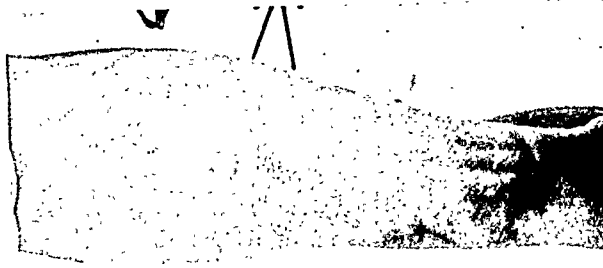


FIG. 14. Shows negative offspring test from mother animal, third delivery. The papule at the left is the control; the papules marked with a combined line to the right are the reactions.

animal had a second delivery of nine sick living young. On January 12th, six days after the second delivery, six living offspring were killed for brain emulsion. On March 1st, the third delivery by the same mother animal took place; three living young were born. All three were killed eighteen days after the third delivery. On March 24th, the mother animal was dead.

Because the offspring of these deliveries were killed one week after the second delivery and two and a half weeks after the third delivery, the lymphogranulomatous virus may have been transmitted here by another source of infection and not by the placenta.

We could advance the same argument in all three deliveries of the offspring animal (October 12, 1942; January 12, 1943; March 1, 1943), in which not immediately after delivery, but (1) sixteen days after first delivery, 4 offspring were killed; (2) seven days after second delivery, nine offspring were killed; and (3) eleven days after third delivery, seven offspring were killed.

It will now be shown in Table II what results were obtained from the offspring tests of the second and third deliveries of the mother mouse, and what results from the offspring tests of the three deliveries of the female offspring from the first delivery of the mother mouse. (Figs. 11 to 18.)

mother mouse, and from her female offspring's three deliveries. Twenty-eight of these cases gave positive Frei tests, ten gave negative Frei tests. (Table II.)

To sum up, it has been shown that (1) the offspring tests from the first delivery of an infected pregnant mouse (Exp. Sept., 1942) were twelve times positive in fourteen cases with a positive Frei test; (2) the offspring tests of the second delivery of the same mother mouse and the offspring tests of the first and second deliveries of the female offspring of the same mouse were positive sixteen times in twenty-eight cases with a positive Frei test. This striking fact seems not to be the effect of a passive transmission of immune bodies, but of the transmission of a living virus. If the offspring tests of the third deliveries show weaker results (Table II), is it likely that in the third delivery the virulence of the lymphogranuloma virus is decreasing? The death of the mother mouse a week after its third delivery speaks against this theory.

The surface sterility tests of all the brains were sterile without exception. The clinical pictures, however, of forty-two mice with three or four intracerebral transmissions of the offspring brain emulsions from the six different deliveries of the mother and of the offspring were not strikingly different from each other. The offspring brain emulsions of the six de-

liveries in their intracerebral transmissions produced sickness or death after forty-eight hours or later with very few exceptions.

We have made the same observations with four other mother animals in two different experiments. Three of them had three deliveries; one, only two. There was

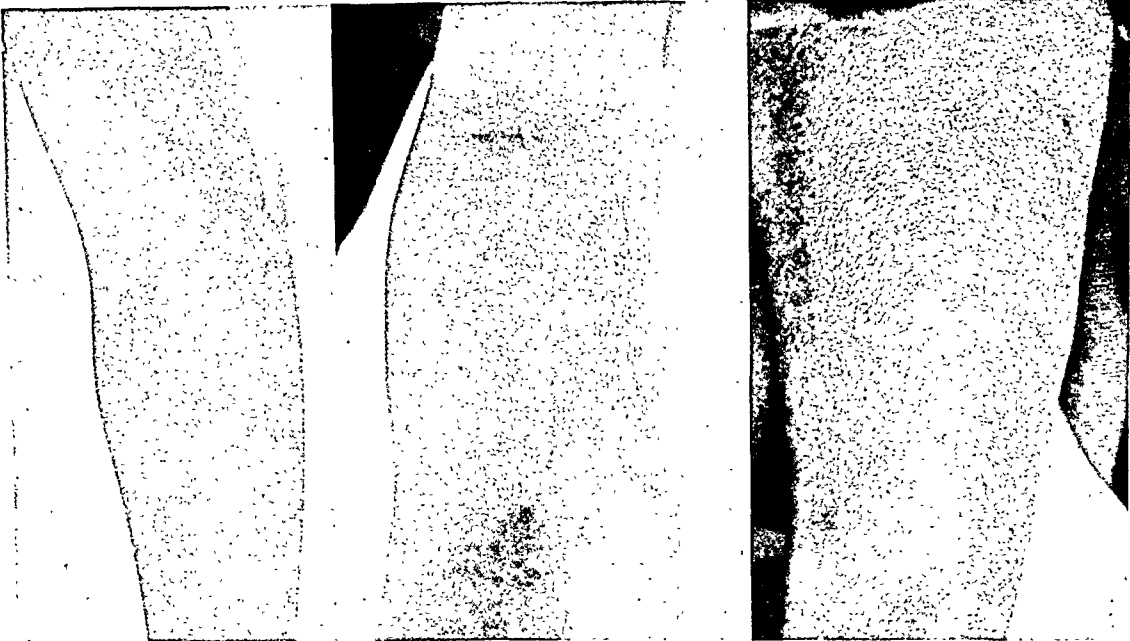


FIG. 15.

FIG. 16.

FIG. 17.

FIGS. 15 to 17. Show positive offspring tests from offspring brain emulsions of female offspring, first and second deliveries. In all three illustrations the single upper papules represent the controls; the two lower papules the reactions.

In this respect, the death of another *mother* mouse in the same experiment is instructive. It was first delivered six weeks

no delivery by the one female offspring. The time between the first and second delivery of one animal was one month;

TABLE II

ANTIGENS OF OFFSPRING BRAINS FROM FIRST, SECOND AND THIRD DELIVERIES OF MOTHER MOUSE AND OFFSPRING

|                                      |                      | Frei<br>Test,<br>Positive | Offspring Test |                  |          |          |
|--------------------------------------|----------------------|---------------------------|----------------|------------------|----------|----------|
|                                      |                      |                           | Positive       | Positive<br>Weak | Question | Negative |
| Mother animal #3.....                | Del. 2 and Tr. 1     | 9                         | 4              | 2                | 1        | 2        |
| Female offspring of mother animal #3 | Del. 3               | 5                         | ..             | ..               | ..       | 5        |
|                                      | Del. 1 and Tr. { 1/2 | 6                         | 6              |                  |          |          |
|                                      | { 3/4                |                           |                |                  |          |          |
|                                      | Del. 2 and Tr. { 1/2 | 4                         | 4              |                  |          |          |
|                                      | { 3                  |                           |                |                  |          |          |
|                                      | Del. 3 and Tr. { 1/2 | 4                         | 1              | ..               | ..       | 3        |
|                                      | { 3                  |                           |                |                  |          |          |

after inoculation; the second delivery occurred four weeks later. The animal died four weeks after the second delivery.

of the second, four and one-half months; of the third, five months. Between the first and third deliveries there was an interval

of two and one-half months, five months and seven months, respectively.

The offspring of one mother animal were

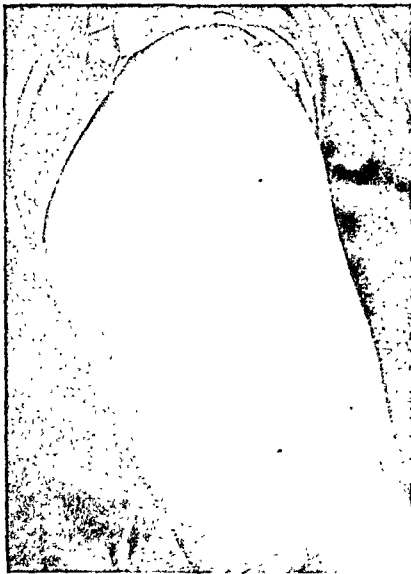


FIG. 18.\* Shows a negative offspring test from mother, second delivery, in a case with a negative Frei test. The upper papule is a negative Frei test reaction, and the lower papule is a negative offspring reaction.

killed immediately after a second delivery, and of two mother animals after third de-

teen, and twenty-five days; and some five months after the first, second, and third deliveries.

These facts and their positive tests, which are similar to the above mentioned, give further evidence of the transmission of lymphogranuloma venereum through the placenta, since three groups of offspring have been killed immediately after the second and third deliveries. The facts show also the dangerous persistency of the virus through the second and third deliveries of the mother and offspring.

Frei tests also appeared to be positive in the abdomen of the young of the second delivery, three times from two different experiments. In this respect, I may mention again the record of a case in this article, in which a lymphogranulomatous swelling arose in the abdominal skin around the penis of a seven and one-half-months old mouse, in a case in which the mother mouse had been infected subcutaneously with lymphogranulomatous virus.

These experimental results suggest the danger which possibly threatens the newborn child of a lymphogranulomatous mother. These facts have also important

TABLE III

|                                      |                             | Frei Test,<br>Negative | Offspring Test |               |          |          |
|--------------------------------------|-----------------------------|------------------------|----------------|---------------|----------|----------|
|                                      |                             |                        | Positive       | Positive Weak | Question | Negative |
| Mother animal #3.....                | Del. 2 and Tr. 1/2          | 3                      | ..             | ..            | ..       | 3        |
|                                      | Del. 3 and Tr. 1            | 1                      | ..             | ..            | ..       | 1        |
| Female offspring of mother animal #3 | Del. 1 and Tr. { 1/2<br>3/4 | 2                      | 1              | ..            | ..       | 1        |
|                                      | Del. 2 and Tr. { 1/2<br>3   | 4                      | ..             | ..            | 1        | 3        |

Note: Del. means delivery; Tr. means transmission.

liveries. In the other three mother animals, some of the offspring were killed two, seven-

\* Measurements of the tests in Figs. 11 to 18: Fig. 11: 0, 3:0, 5:0, 5—Control. Fig. 12: 0, 4:0, 6:0, 7—Control. Fig. 13: 0, 3:0, 7:0, 8—Control. Fig. 14: 0, 3:0, 3:0, 3—Control. Fig. 15: 0, 4:0, 6:0, 6—Control. Fig. 16: 0, 3:0, 7:0, 7—Control. Fig. 17: 0, 4:0, 6:0, 7—Control. Fig. 18: 0, 2:0, 3—Control.

relationship to the Frei test in childhood, when the lymphogranulomatous mother has given birth to offspring. Levy<sup>13</sup> asks: "Is a positive test in early infancy merely an indication of immune bodies transmitted through the placenta? If so, will the Frei test become negative later, or will the disease

become manifest clinically at a later age?" The answer is that the disease in early infancy, with a positive Frei test, may possibly manifest itself clinically at a later age.

We have yet to describe the fate of eighteen living offspring, in two subcutaneous experiments, which were left with the mother animal after delivery. We believe that in all these cases the lymphogranuloma virus was transmitted through the placenta. That they were infected with lymphogranuloma virus is evident from the following facts: Six offspring were born three to nine days after inoculation; one offspring was dead three days after delivery; one was killed two days after delivery; two were killed four days after delivery, and two were eaten by the mother animal ten days after delivery. Skin tests of the offspring were positive; elementary bodies were found; intracerebral transmissions showed sickness and death of other mice.

Two living offspring by another animal were delivered in another subcutaneous experiment four days after infection; they were killed two months later. Three transmissions in mice showed sickness and death with six positive skin tests of the offspring as well as initial bodies. Three yolk sac transmissions from offspring brains showed sickness and death of the infected eggs and elementary and initial bodies in the yolk sac.

In another case, the infected mother animal of the last experiment was not pregnant, but delivered five living offspring five months later; these were killed ten days after delivery. The mice on which an intracerebral transmission was made were sick two, six, and eight days after transmission, then recuperated.

The question as to whether in all these different cases the lymphogranulomatous virus was transmitted through the placenta, I should like to answer in the affirmative, because the whole clinical picture as one essential test; the controls, and the

virus tests are in accordance with each other.

Five living offspring were born twenty-four hours after subcutaneous infection of another animal. One offspring died forty-one days later. The remaining four were ill on the fifty-first day, but did not die. One was killed five months later. The offspring test in a human being was negative, but three intracerebral transmissions showed sickness and death of the animals on which transmissions were made. One of two offspring eight months later showed a positive Frei test in the skin of the abdomen; one offspring showed a lymphogranulomatous swelling around the penis.

We have to assume that because the mother animal was delivered twenty-four hours after subcutaneous infection, the effect on the fetus through the placenta in this case would not be great. Therefore, it is to be understood why one of five offspring died five weeks later, and four survived from five to seven and a half months.

The above mentioned negative offspring test in a human being with a positive Frei test is in interesting contrast to a positive Frei test in the skin of the abdomen of one of the supposedly healthy offspring, and seems to demonstrate the latency of the lymphogranuloma virus.

It may be objected that after transmission of the virus through the placenta the offspring may recuperate and later new lymphogranulomatous developments could be caused through a new inoculation by contact. But the fate of the living offspring shows clearly the persistency of an active virus. Active virus protects, however, against a second inoculation of the same virus, according to Rivers<sup>10</sup> and Bieling.<sup>11</sup> Bieling says, "In the course of the lymphogranulomatous disease, a resistance against a venereal infection with living virus develops."

The following review of the literature will show that the question of any hereditary or congenital transmission of the lymphogranuloma virus in childhood is not decided yet.



William Dick,<sup>9</sup> in Prague, reported in 1936 the case of an infant whose parents had this disease, and who showed a positive Frei test at the age of two weeks and again at five months with no clinical symptoms of lymphogranuloma virus.

Before Dick, in a discussion before the American Medical Association in 1934, John Eric Dalton<sup>12</sup> answered a question of Walter S. Grant about experiences with positive Frei tests in children in the case of lymphogranulomatosis in mothers, as follows: "I have had the opportunity to study two children, born of mothers who suffered from acute lymphogranulomatosis inguinale. The acute glandular process in one of the mothers occurred just preceding conception, while in the other it appeared during pregnancy. In each case, the child has been watched with periodic Frei tests over a period of a year, with completely negative results."

Harold Levy<sup>13</sup> evaluated in 1937 nine cases of lymphogranuloma virus in childhood and reported an additional case. In a six-year old female colored child, painful swellings appeared in both groins. The Frei test was slightly doubtful for about three to four weeks then positive. The parents, who were both being treated for syphilis in another clinic, were discovered to have lymphogranuloma venereum after diagnosis was made in the child. Levy continues: "Until recently, direct contact was thought to be the only kind of transmission of the disease. Dick, however, reported the case of an infant whose parents had the disease, and who showed a positive Frei test at the age of two, and again at five months, with no clinical symptoms of lymphogranuloma venereum, although the positive test may have been a transmitted allergic reaction from the mother. This is unlikely in view of the persistently positive skin test."

Melczer and K. Sipos<sup>14</sup> reported the case of a three-year old daughter of a mother with elephantiasis genitoretalis. The child had a strong positive Frei test in intervals of fourteen days, but five months later the

Frei test was absolutely negative. The authors believe, therefore, that the first results were not specific, and that this case cannot be evaluated as congenital lymphogranuloma venereum.

Melczer and Sipos refer to the cases of Ferrari,<sup>15</sup> Michelson, Crotty, and Kesselberg,<sup>16</sup> and Coutts-Moneta<sup>17</sup> with negative Frei tests of the newborn from lymphogranulomatous mothers, and they believe that the question of the intra-uterine infection of the fetus has not been clarified as yet, and that the occurrence of congenital lymphogranuloma venereum can be decided only by larger statistical material.

In 1940, Levy<sup>18</sup> reports an additional case of lymphogranuloma venereum in childhood and says: "The Frei test is not found until a period of three to eight weeks has elapsed from the time of infection. A temporary negative Frei test may occasionally be present, due to cutaneous allergy in certain cases of prolonged or relapsing lymphogranuloma venereum with lessened general resistance. Other reasons may be concurrent—early florid syphilis, chancroid, active tuberculosis, high fever, and occasional gonorrhea. False positive Frei tests may result from antigen contamination with bacteria." Another reason is suggested in the following statement of Gregoria: "Specific sensitization may co-exist with other diseases—syphilis, for example—and give rise to apparently non-specific reactions in those diseases."

In 1941, V. Pereira and I. B. Gil<sup>19</sup> published a case of a girl eighteen months old and a photograph showing bilateral lymphogranulomatous swelling of this patient. There was a strong positive Frei test. The parents had a positive Frei test, too, and syphilitic papules. The authors believe that the child was extragenitally infected by the parents, lying with them in their bed. But there is no proof of this. It may be congenital or not.

According to Wilson and Hesselthine<sup>20</sup> the indisputable evidence of Dummer and Tamura,<sup>21</sup> Melczer and Sipos,<sup>14</sup> Sonck<sup>22</sup> and Levy<sup>13,18</sup> has established the juvenile

group. These authors emphasize that these cases are not congenital transmissions, but acquired infections after the natal day. These children developed the same type of syndrome as the adult.

C. Leon Wilson and H. Close Hesselthine<sup>20</sup> published "cases of nineteen babies born of and breast-fed by mothers with a latent lymphogranuloma virus who have been normal and free from the disease. Only one baby in thirteen cases showed any evidence of passive transfer of antigenic bodies. In spite of two positive tests (on the third and tenth days), the test became negative within three months, and so remained."

The authors pointed out that all of the mothers apparently were in the latent stage of the disease, and therefore probably non-infectious. They continue: "It would be worth-while, indeed, to find a sufficient number of pregnant women who had the disease in the *active* phase, particularly if one could prove a systemic manifestation in them. If *this* virus passed through the placenta, *much* damage could result; but again, the fetus, like the mother, might have little or no residual damage. If, on the other hand, the damage was severe, extensive, or lethal, an abortion or still-birth could be expected."

#### CONCLUSIONS

1. Additional data are presented showing that in mice the virus of lymphogranuloma venereum, when injected subcutaneously into pregnant mice, can pass through the placenta and infect the fetus.

2. Initial bodies and elementary bodies could be demonstrated in smears and offspring brain tissue.

3. A male offspring eight months after delivery from an infected pregnant mouse showed a positive Frei test in the abdominal wall.

4. A male offspring seven and one-half months after delivery from a pregnant mouse, infected with lymphogranuloma venereum material, presented changes in

the skin of the lower abdomen which are attributed to intra-uterine lymphogranulomatous infection. The finding of elementary bodies in the subcutaneous skin tissue, and the positive Frei test obtained in two human patients with antigens from the skin emulsion of the mouse, are taken as proof that lymphogranulomatous infection has occurred.

5. The offspring tests from the first delivery of an infected pregnant mouse in the experiment were twelve times positive in fourteen cases with a positive Frei test.

6. The offspring tests from the second delivery of the same mother animal, and the offspring tests of the first and second delivery of the female offspring of the same animal were nineteen times positive in twenty-eight cases with a positive Frei test.

7. The offspring tests from the third delivery of the same mother (five) and offspring (four) were eight times negative in nine cases with positive Frei tests.

8. The surface sterility tests of forty-two mice, into which intracerebral transmissions of offspring brain emulsions from the six deliveries of mother and offspring have been made, were sterile without exception.

9. The clinical picture of these forty-two mice showed sickness and death forty-eight hours later, and only a few recuperated after intracerebral transmissions. In this respect, however, there was no striking difference between mother and female offspring between first, second, and third deliveries.

10. The fate of eighteen living offspring which had been saved for the mother animal after delivery has been described.

11. All this gives not only further evidence of the transmission of the lymphogranuloma virus through the placenta, as must be suggested in the three deliveries of mother and female offspring, when the offspring was killed a few hours after delivery, but also indicates the persistency of the virus.

12. The clinical question whether there is any occurrence of congenital lympho-

granulomatosis in human beings, should be studied with a greater amount of statistical material. We must then differentiate between the two groups of lymphogranulomatous women: (1) Mothers who were apparently in the latent stage of the disease, and (2) mothers who were in the active stage of the disease; that is to say, to investigate and find if there is a systemic manifestation in them. The last group especially would be of interest in this respect. Also the aforementioned suggestion of W. Frei for "research work on so-called latent forms" would be very helpful.

13. If such research work is to be done in the future, the question immediately arises whether it will be necessary to treat the disease of the human fetus in the uterus, of the newborn after delivery, or of the child at a later stage, and how this is to be done.

I am deeply grateful to Drs. M. Sanders, H. Curth, A. E. Braley, C. K. Smelser, W. Pyles, and Mr. A. Feinberg and Mr. H. Pebler for their friendly collaboration; and to Dr. J. G. Hopkins for his permission to make tests in the Department of Dermatology, Presbyterian Hospital, in New York City.

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# THE USE OF THROMBIN (TOPICAL) IN TRANSURETHRAL RESECTION OF THE PROSTATE\*

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TRANSURETHRAL resection of the prostate has long since become a standard surgical procedure, for which, however, the ultimate in instruments, technics and adjuvants to the surgery has not yet been reached. Periodically we find innovations and modifications introduced which simplify the procedure and increase the safety factor. The most recent addition to this field has been the use of Thrombin (Topical) as a hemostatic agent following the resection.

Heretofore one of the principal hazards of transurethral prostatic surgery has been postoperative bleeding and the difficulty in controlling it. Blood clots formed in the bladder necessitated frequent change of indwelling catheters and the use of rigid catheters and evacuating syringes. Not infrequently, the patient had to be returned to the operating room for evacuation of clots per urethram, or on occasion, suprapubic cystostomy for the removal of blood clots from the bladder had to be performed secondarily. To prevent this clot formation, bladder irrigations have been utilized intermittently or continuously. For the latter, various devices and multi-channeled catheters have been employed; and at best, there is moderate difficulty in making these drain properly, thus causing considerable postoperative anxiety. In addition, various solutions have been employed, ranging from normal saline and

boric acid for irrigation alone, to anticoagulants such as sodium citrate solution or to styptics such as alum solution.

No matter which of these various catheters, irrigating appliances or solutions were used, constant alertness was necessary, thus entailing a high degree of personnel attention and at times necessitating continuous nursing care for each patient following transurethral prostatic surgery. Added disturbance and discomfort to the patient were produced by the frequent irrigations which would occasionally cause severe vesical spasms, and become a torment to the patient. In addition there was the great factor of blood loss which might continue for a number of days following the operation and considerably retard the patient's convalescence and recovery, and which might necessitate repeated transfusions. It is a tribute to transurethral prostatic resection that among the many confusions mentioned here, and others, it has become a surgical measure of distinct merit.

It would then be a tremendous boon to have a method of controlling or, at least, modifying the major problem of bleeding following transurethral resection of the prostate. Such an agent, we believe, has been found in the use of Thrombin (Topical). We may well confess that in our early use of this preparation, we were extremely reluctant to abandon bladder irrigations,

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for this appeared to be foolhardy and seemed to invite disaster. Nevertheless, after considerable trial, we can recommend this material as a potent agent in the control of the bleeding.

Two reports on the clinical use of Thrombin (Topical) have already appeared: the first report, that of O'Connor<sup>1</sup> presents his technic for the use of the Thrombin (Topical) and comments on his experience with the conclusion that it has been most satisfactory. Palomo<sup>2</sup> also cites a series of cases in which this preparation has been successfully employed. Our own presentation here is confirmatory of the satisfactory results obtained with Thrombin (Topical) in a group of fifty cases. Moreover, we have analyzed our results and compared them with an equal number of cases in which no Thrombin (Topical) was employed. This comparative group comprised those cases immediately preceding the clinical trial of Thrombin (Topical). All cases are from the one urologic service at the New York Post-Graduate Hospital and the patients were operated upon by the same individuals, so that, so far as we can ascertain, all conditions are the same, and comparisons are proper.

#### THEORY OF THE USE OF THROMBIN (TOPICAL)

Thrombin (Topical) is a highly purified extract of bovine blood, the allergenic factors for patients sensitive to beef proteins having been removed. In the normal clotting mechanism, thrombin, a product of the action of thromboplastin upon prothrombin in the presence of ionized calcium, acts upon fibrinogen to produce fibrin, which is the clot.

The clotting power of thrombin *in vitro* is quite remarkable, 1 mg. of the purest fraction being capable of clotting approximately 1½ liters of standardized fibrinogen solution in fifteen seconds. Whole blood is similarly responsive to its properties. Commercial thrombin has been standardized so that one Iowa unit is the amount necessary to clot 1 cc. of fibrinogen solution in

fifteen seconds. The product is sensitive to heat and is destroyed at 52°C. and its activity is also destroyed by weak acids and alkalis. It is readily soluble in water, but solutions begin to lose their activity at room temperature after a day or two. The dry powdered preparation, however, is stable for years. Topical application to operative surfaces produces no untoward effect, *but it must not be used by intravenous injection*, for introduction intravascularly might easily result in fatal thrombosis. Its hemostatic effect when applied topically is dependent upon the formation of a thin adherent clot which forms on the surface of the bleeding tissue, *not within the vessels themselves*. It is best used upon a surface which has been washed relatively free of blood, for if a thick layer of blood is present, it tends to clot only the surface layers, permitting bleeding to continue beneath the surface. It may also be employed by spray or by flooding the area with the solution, or by gently rubbing the solution on the raw area with the gloved finger.\*

#### METHOD OF USE

Our method for the use of Thrombin (Topical) in transurethral surgery has been quite simple. First it must be emphasized that our standards for resection technic have not been altered by its use; we look upon this preparation as an adjuvant in postoperative care, not as a short cut in transurethral resection. From our observations thus far, it may be said that in transurethral surgery of the prostate, we may expect Thrombin (Topical) to control venous and capillary oozing, but not arterial spurters or large open venous sinuses. With the confidence we have gained in its use, we are less apt to fall into the evil of over-coagulation with its frequently attendant, late secondary hemorrhage and prolonged periods of convalescence. Indeed, we believe strongly

\*The material used was supplied unstintingly in ampuls of 5,000 and 10,000 units by the Department of Clinical Investigation, Parke, Davis & Company of Detroit, Michigan, to whom we are greatly indebted.

that the minimization of coagulation consistent with good surgery hastens healing and markedly lessens the late postoperative discomfort.

When resection of the prostatic tissue has been completed, and all arterial spurters have been coagulated, a number 24 F. Foley catheter with a 30 cc. bag is introduced and the bladder is irrigated until the return flow is quite clear. The catheter is then withdrawn until the eyes are in the prostatic urethra. Using an ordinary 10 cc. syringe with a Pomeroy ear tip serving as an adapter, 5,000 to 10,000 units of Thrombin (Topical) in 10 cc. of solution, are slowly injected through the catheter, following which 5 cc. of air are immediately injected to drive all the solution out of the catheter into the urethra. The catheter is clamped and allowed to remain *in situ* for *five minutes by the clock*, at the end of which time it is gently advanced into the bladder and the bag is distended. We have not found it necessary to depend upon any especially designed catheter with additional channels. The catheter remains clamped for forty-five to sixty minutes when siphon drainage into a bottle is established. Traction upon the catheter has not been necessary for control of bleeding and irrigations have been entirely abandoned. The drainage is characteristically dark brown or black and gradually becomes lighter in color until, in most cases, it is perfectly clear in eighteen to thirty-six hours after resection. Occasionally we have noted perfectly clear urinary drainage in as short a time as eight hours. Unless the procedure has been an obvious failure, a most unusual circumstance, there are no clots present in the drainage, and there is no clot formation in the bladder. Intravenous fluids are given postoperatively. Whole blood by transfusion is given when indicated, only if there has been serious blood loss during the operation. The catheter is usually removed twenty-four hours after the urine has become clear.

## RESULTS

We have employed Thrombin (Topical) in fifty resections of the prostate for benign hypertrophy and carcinoma and have compared our results with the fifty resections immediately preceding in which bladder irrigations were used in the postoperative management. Table 1 briefly summarizes our statistics on tangible factors:

TABLE 1  
COMPARISON OF CASES OF TRANSURETHRAL RESECTION  
OF THE PROSTATE IN WHICH THROMBIN (TOPICAL)  
WAS AND WAS NOT USED

|                             | No. of<br>Cases | Urine<br>Clear<br>(Hrs.<br>after<br>Re-<br>sec-<br>tion) | Cathe-<br>ter Re-<br>moved<br>(Hrs.<br>after<br>Resec-<br>tion) | Post-<br>opera-<br>tive Hos-<br>pital<br>Stay<br>(Days) | Severe<br>Post-<br>opera-<br>tive Hemor-<br>rhage |
|-----------------------------|-----------------|--|---|---|---|
| No Thrombin<br>employed...  | 50              | 52   | 71  | 8   | 5   |
| Thrombin em-<br>ployed..... | 50              | 27   | 48  | 7   | 1   |

It can be seen that in the patients treated with Thrombin (Topical) the urine was clear and the catheter could be removed in much less time than when irrigations were employed. The urine became clear in an average of twenty-seven hours and the catheter was removed in forty-eight hours in the former group, while in the latter, the urine cleared in fifty-two hours with removal of the catheter in seventy-one hours. The hospital stay was reduced slightly, but not very significantly, from an average of eight days to seven days. Other factors which can not be expressed in figures, however, were even more important. Bladder irrigations were eliminated entirely, reducing nursing care to a minimum. Exasperating experiences with plugged catheters were obviated except in one instance. Physical discomforts such as vesical spasm, occasioned by frequent bladder irrigations were completely absent and mental apprehension was reduced to a minimum by the elimination of a for-

bidding irrigating apparatus or frequent attention to the catheter. Patients fared much better with the least attention consistent with their postoperative course. The amount of blood lost postoperatively was reduced significantly and not only did urinary drainage become clear in half the time, but it is estimated that the amount of blood lost during the period of bleeding was materially decreased. Severe postoperative hemorrhage occurred only once in the entire series of patients treated with Thrombin (Topical) and manifested itself twenty-four hours postoperatively and required fulguration of bleeding areas. On the other hand, bleeding occurred five times in the control series. In one patient, irrigation was begun twelve hours postoperatively, not because of any alarming hemorrhage, but because it was believed that Thrombin (Topical) had not sufficiently controlled the oozing. This case illustrated well that by the use of Thrombin (Topical) one has much to gain and nothing to lose, for irrigations can always be instituted if deemed advisable.

Complications, not related to bleeding, were not altered in their incidence or character and no reactions attributable to the Thrombin (Topical) were encountered.

#### COMMENTS

Our results with the use of Thrombin (Topical) following prostatic resection, have been most gratifying, so much so that we have adopted its use as a regular procedure. The most striking advantages are simplification of the postoperative management and greater comfort and smoother convalescence of the patient. Our enthusiasm has not, however, overriden our realization of its limitations. We must emphasize that rigid adherence

to previous standards of resection technics should not change despite the use of Thrombin (Topical) or any other hemostatic agent. Transurethral surgery of the prostate remains an exacting, highly technical procedure and Thrombin (Topical) as a hemostatic agent must not be used as a substitute for good surgery.

#### SUMMARY AND CONCLUSIONS

1. Thrombin (Topical) has been employed as a hemostatic agent following transurethral resection of the prostate in more than fifty cases, and results compared with an equal number of cases in which this preparation was not used.

2. Results with the use of Thrombin (Topical) were very satisfactory: (a) Postoperative bladder irrigations were completely eliminated, reducing the amount of work necessary. (b) Postoperative bleeding was decreased in amount and duration. (c) The inlying catheter could be removed earlier, and there were fewer postoperative hemorrhages when Thrombin (Topical) was employed than when irrigations were relied upon in the postresection period. (d) The use of 10,000 units was found to be more efficacious than the 5,000 unit preparation. (e) There were no toxic effects nor other disadvantages in the use of Thrombin (Topical).

3. It must be emphasized that Thrombin (Topical) as a hemostatic agent cannot be used as a substitute for careful hemostasis in the technic of transurethral resection of the prostate.

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# URINARY STRESS INCONTINENCE IN THE FEMALE\*

## A COMBINED GYNO-UROLOGICAL APPROACH TO ITS CORRECTION

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THE average recurrence of 20 per cent of the cases of incontinence subsequent to attempts at its surgical correction is in itself evidence that the answer to this distressing problem is as yet wanting. We are consequently of the opinion that a more carefully combined gynecological and urological study of the causative factor, after the exclusion of systemic disturbances, plus a meticulous anatomic restoration of the damaged tissues is of paramount importance. Additional detailed scrutiny into the preoperative, and immediate and late postoperative care will also insure a greater percentage of alleviations of this very troublesome condition.

When the patient presents herself, a careful consideration of her history will usually establish or rule out such extra-gynecological etiologies as orthopedic, neurological, hematologic, or those with a traumatic background. Further, a detailed history may occasionally provide an answer to the elimination of some of the poor results heretofore obtained in the treatment of the condition by making us appreciative of various combinations. The fact that a woman has sustained a traumatic delivery, or has had multiple pregnancies often side tracks the physician and renders him non-cognizant of concomitant systemic residues which could

easily provide the answer to the entire situation.

The history is followed by a complete physical examination to determine the status of all systems, followed by confirmatory laboratory procedures. The latter include a complete blood count, (noting especially the color index), complete urinalysis, Wassermann, and an x-ray film of the lower spine. The roentgenogram may of occasion reveal an often unsuspected occult spina bifida, which is a very frequently overlooked cause of urinary incontinence.

After concluding from the history, physical examination, and laboratory findings that the urinary stress leakage is not due to extraneous causes, we then, and only then proceed with a gyno-urological study to determine the extra- and intracystic and extra- and intraurethral status. Cystourethroscopy has been very advantageous and has provided the answer to many of our incontinence problems. By this type of endoscopic study we have quite frequently discovered etiologies for incontinence which were not due to pure anatomic changes, and which, therefore, could not have been corrected by attempted surgical repair.

Some of the occasionally overlooked "non-operative" causes of incontinence, we have found, are chronic follicular

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urethritis and trigonitis, paradoxical incontinence, bladder diverticulas with a concomitant low grade inflammatory process, urethral diverticulas, and suburethral cysts. Nor must one omit a ball-valve polyp of the vesical neck which prolapses into the urethra, or a ball-valve stone. Strictures of the urethra also produce a psuedo-incontinence by retaining urine behind them; upon complete urethral relaxation after micturition, the retained urine drips out when the woman assumes the erect position.

The usual etiology of the so-called "true operative cases" is childbearing, but other causes must be considered. These are coitus against congenitally weak tissues, trauma, and continued friction such as seen in women who have ridden horses or bicycles over a long period of time, and chronic masturbators of the intravaginal type.

#### URETHROCYSTOSCOPIC FINDINGS

In the above "true surgical cases," the endoscopic findings are definite. There is a loss of normal contour of the vesical neck and of the urethra. Definite sagging or flattening of the posterior commissure of the neck is found, and to such a level as to make the trigone on an even level with the floor of the urethra. In other words, the normal angle between the internal orifice of the urethra and the floor of the bladder is altered. This being so, the involuntary sphincter at the vesical neck, or Bells muscle, is rendered physiologically incapable, and at no time, therefore, is the bladder neck completely closed. There is also a definite sagging of the floor of the urethra, especially in its upper two-thirds. When a urethrocele is present, a pocket, or what appears to be a diverticulous opening in the floor of the urethra and bladder neck is seen.

The trigone is shortened postero-anteriorly, and consequently the interureteric ridge is closer than is normal to the vesical neck. The ureteral orifices are therefore also closer to the neck of the bladder.

In the normal female, the long axis of the urethra is at right angles to the floor of the bladder. In the "true operative cases" the angle is decreased, and in the severe cases there is no angle whatsoever present.

As a routine during the endoscopic examination, the patient is told to urinate with the cystoscope in place. In a normal female, the posterior commissure is elevated from 2 to 2.5 cm. during this procedure, whereas in the truly incontinent patients there is no more than  $\frac{1}{2}$  cm. elevation, and in the severe cases there is no elevation noted. In all of this work the McCarthy Foroblique cystoscope is employed.

#### ANATOMICO-CLINICAL CONSIDERATIONS GENERAL FEATURES

During the process of fetal development, the anterior portion of the urogenital section of the cloaca is designated as the allantoic space. It is the upper division of the space which becomes expanded, and eventually gives rise to the summit of the urinary bladder, while the caudal end forms the corpus and fundus vesicae. The urethral tube is, in turn, derived from the lowermost portion of this same space. Both of these viscera ultimately garner their supporting elements from the differentiated and undifferentiated mesenchyme which is located at or near their point of origin. They are secondarily supported by certain other viscera which spring from entirely different anlage than themselves, but because these organs are environmental, they serve as organs of attachment.

The bladder is situated in the midline of the anterior pelvic hemisphere and is firmly imbedded in the pelvic floor. Its base and inferior surface are in contact with the posterior aspect of the pubis, the levator ani and their overlying fascia, and between the medial margins of the latter, with the upper surface of the urogenital diaphragm. Its strong attachment to the pelvic floor and urogenital diaphragm is gained through the medium of the strong

tendinous arches of the pelvic fascia, and the pubovesical ligaments. This fixed portion forms part of the vesical platform. The rest of the bladder is separated from the pelvic walls and floor by fatty and areolar tissue. The cervix uteri and upper part of the vagina help support the base of the bladder by virtue of the fact that the bladder is loosely attached to them; by their attachment to the pelvic walls, they further act as an aid in indirectly suspending this viscus. If they fall, the vesical fundus must also, of necessity, descend.

The urethra, the canal of exit, or excretory duct of the bladder, is a tube which varies from 2.5 cm. to 4 cm. in length. It is curved slightly upward with its concavity forward. It is firmly attached to the anterior vaginal wall, and therefore describes the same angle as the vagina, which is about 45 to 55 degrees with the horizontal, and is therefore approximately parallel with the plane of the pelvic brim. When not distended, the urethral mucous membrane is more or less corrugated throughout its length due to the sphincteric action of its surrounding muscle fibers and fascia. Further, it is firmly attached to the pubic arch by the strong medial pubovesical ligament. The uppermost portion of the canal is imbedded in the pelvic floor in connection with its mother viscus, the bladder. It enters at once into the urogenital diaphragm between the layers of which it is surrounded by the fibers of the sphincter urethrae muscle. It is also, together with the vagina, influenced at its lower end by the so-called sphincter vaginae, or bulbocavernosus muscle.

#### PERTINENT FEATURES

*Intrinsic Bladder Musculature.* The muscularis of the bladder consists of unstriated fibers arranged in three layers, namely, an external longitudinal, a middle circular, and an internal longitudinal coat. The middle circular layer is of utmost importance due to the fact that its fibers converge toward the urethro-vesical junc-

tion, the so-called vesical neck, and surround it in collar-like fashion, thereby creating a strong involuntary muscular ring which is known as the internal urethral sphincter. This ring is the most internally situated of a series of sphincters which is encountered along the length of the urethra from the vesical neck toward the external meatus.

The internal urethral sphincter, then, plays a very important rôle in the continence of urine, and it is this muscular ring which is isolated and plicated in the Kelly plastic procedure for the correction of urinary stress incontinence. However, since it is only one of the several sphincter factors in the control of urinary flow, its repair alone is definitely not sufficient in the correction of impaired urinary control.

*Intrinsic Musculature of the Urethra.* The muscular coat of the urethra is composed of two layers of smooth fibres, an inner longitudinal and an outer circular.

This coat might be said to possess a centrifugal action in that it contracts with equal force from all points on the periphery toward the center of the urethral lumen. The tendency toward marked reduction of the lumen calibre is at once apparent.

It is reasonable to assume that the forces which create urinary incontinence must necessarily include the urethral musculature and produce some anatomico-physiological disturbances in it. However, it is not feasible to attempt to repair these fibers during surgery for incontinence.

*The Pubocervical Tissues.* The viscera are set in the midline of the pelvis, leaving a good deal of space between them and the pelvic walls. The spaces between the peritoneum above, the pelvic walls laterally, the viscera medially, and the pelvic floor inferiorly are all filled with connective tissue. It is this tissue which is developmentally derived from the undifferentiated mesenchyme of the embryo, and by its local condensations also provides fascial coverings for the viscera, sheaths for their ducts, coats for the nerves and vessels, the so-called neurovascular bundles, and

epimysial lamellae on the pelvic face of the muscles.

Around the visceral canals the pelvic

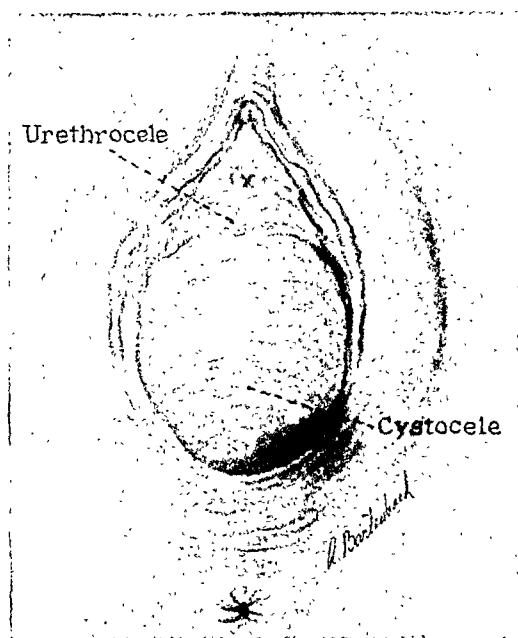


FIG. 1. Frontal view of cystocele and urethrocele.

connective tissue becomes condensed and fuses with the pelvic fascia where it is reflected on to the walls of the urethra, bladder, and vagina to form more or less strong sheaths for these structures. The neurovascular bundles spread out and fuse with these sheaths just as their nerves and vessels reach the organs they supply. Thus we find that the aforementioned viscera are all firmly fixed to the pelvic floor by a fusion of three different sets of tissue: the pelvic fascia, the pelvic connective tissue *per se*, and the sheaths of the neurovascular bundles.

A structure frequently referred to in the gynecologic literature is the so-called uteropubic fascia or pubocervical muscle. This is in reality a name applied to the loose and condensed connective tissue which is associated with the angle between the base of the bladder, the urogenital diaphragm, and the medial margin of the levator ani on either side of the midline, uniting the bladder to these structures, and the structures to one another. It is,

then, a very definite entity which extends from the pubes to the upper part of the vagina, where it fuses with the connective tissue of that area and also with that of the para-cervical region. Through these connections along the lateral borders of the cervix and vagina, the pubocervical tissues link up with the neurovascular bundles of the parametrium. Thus they receive an accessory indirect attachment to the pelvic walls by way of this medium.

The downward prolongations of the pubocervical tissue also find their way between the bladder base and anterior vaginal wall. In this location, it should be referred to as the vesicovaginal fascia, but is more frequently spoken of as pubocervical or perivaginal. Here it is of a loose areolar type, which means that only a frail connection exists between bladder muscularis and the musculature of the vaginal wall. A line of cleavage is therefore easily found and followed in the process of separating the anterior vaginal wall from the bladder base during cystocele repair, and when the dissection is at an end, the pubocervical tissue will be found on the presenting surface of the vesical fundus. By properly plicating the tissue, a portion of the platform upon which the bladder rests is made taut, and the fundus vesicae therefore elevated on its transverse and longitudinal axes.

Marked reduction in the size of a cystocele, or even its entire disappearance may be accomplished by this procedure. By doing away with the abnormal pouch of bladder, the drag is taken away from the posterior urethral wall, especially in the regions of the internal voluntary and involuntary sphincters. That this is a great aid in restoring urinary continence, goes without saying.

In direct contrast to the situation which prevails between bladder and vaginal wall is that which occurs between the posterior urethral wall and anterior vagina. Here the urethral tube is exceedingly firmly adherent and imbedded. Most of the

anatomical and gynecological texts make mention of a urethrovaginal septum. However, the admirable work of Goff has

riorly to the lower border of the pubis anteriorly. From it arise some of the fibers of the levator ani, and, it is therefore

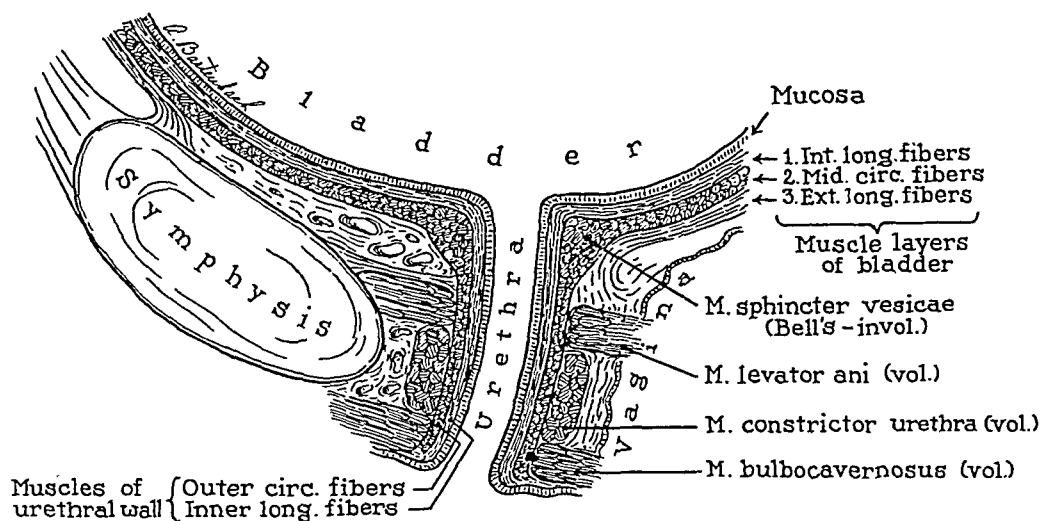


FIG. 2. Diagrammatic analysis of inherent musculature of bladder and urethra, and extrinsic muscular sphincter apparatus.

demonstrated that no fascia or areolar tissue exists between the posterior urethral and anterior vaginal walls, and that muscularis of the urethra and the muscular coat of the vagina are in firm contact with one another. This means that no plane of cleavage exists between the two organs, and is an exceedingly important point to bear in mind during surgery of the region. In the course of exposing the urethra, comparative difficulty will usually be encountered. However, if one remembers that in order to expose this organ, its muscular coat must be directly separated from the muscularis of the anterior vaginal wall, serious injury to it may be avoided.

*The Tendinous Arches and Pubovesical Ligaments.* Much confusion exists in regard to the tendinous arches, or as they are also known, the *Archi Tendinei* or *White Lines*. Perhaps this is so because most textbooks do not make clear the fact that the pelvis possesses four arches, two on either side.

On the obturator internus fascia a white thickening occurs near the level of the obturator foramen. This "white line" courses forward and medially, describing a slight arch, from the ischial spine poste-

known as the tendinous arch of the levator ani muscle. It is not, *per se*, an important factor in pelvic visceral support.

Upon the fascia which covers the superior or pelvic surface of the levator ani, a second white thickening is apparent. It, like the previously described arch, courses from the ischial spine to the pubis, diverging from the white line of the levator as it approaches the pubis, and inserting lower down on the pubis than the latter. It lies at a lower level than the levator arch, and is therefore sometimes referred to as "the lower tendinous arch." Because of the fact that the fascia endopelvina takes origin from it, this structure is also known as the "white line of the pelvic fascia" or the "tendinous arch of the pelvic fascia."

As they approach the pubes the lower arches lend strong support to the sides of the bladder base, and near its insertion into the pubis, the arch on each side gives off two strong projecting limbs. The most lateral of these also lends great aid in bladder fundus support, and is known as the lateral pubovesical ligament, or "lateral true ligament of the bladder." The medial limb dips downward even more medially

to fuse with its fellow of the opposite side to form the medial pubovesical ligament, or so-called "medial true ligament of the

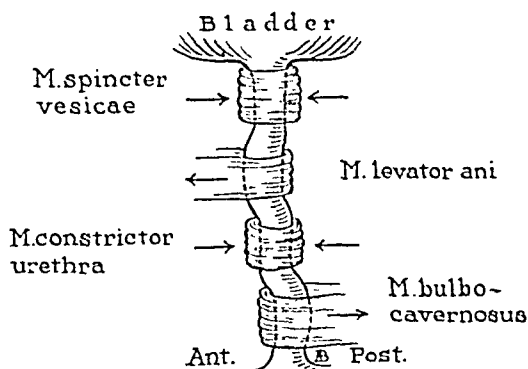


FIG. 3. Diagrammatic analysis of urethral sphincter mechanism. The circumferential compressing effect of sphincter vesicae and constrictor urethrae muscle is shown. Angulation of urethra in opposite directions by levator ani fibers and bulbocavernosus muscle is also illustrated.

bladder." It is this prolongation or branch of the lower tendinous arch which so admirably helps to support the anterior aspect of the bladder base, and which so firmly slings the urethra to the pubic arch.

Needless to say, it is not feasible to utilize the tendinous arches of the pelvic fascia directly, or the medial and lateral pubovesical ligaments in the surgical correction of cysto-urethrocele. However, if one takes cognizance of the fact that these structures take origin from the superior fascia of the pelvic diaphragm, and are therefore intimately connected with that diaphragm, he must at once realize that by taking up the slack in the pelvic floor by means of a posterior colpoperineorrhaphy, he indirectly restores the resiliency of the tendinous arches and pubovesical ligaments. This of course helps to create a strong urethrovesical platform, and to more strongly anchor the urethra to the pubic arch.

*The Pelvic Floor.* The pelvic floor is embryologically derived from the sacral myotomes, and since it represents the flexors and abductors of the tail, it plays a rôle in the human which is phylogenetically unsuited to it. The floor *per se*

should include the levator ani and coccygeus muscles and the strong fascia on their upper or pelvic surface, together with a thinner fascia on their inferior or perineal aspect. Since the viscera under consideration in this communication are situated in the anterior portion of the pelvic cavity, we concern ourselves only with the anterior division of the floor, the musculature of which is made up by the levator.

The division of the levator ani muscle which is associated with the genital hiatus is broad and bandlike. It includes the pubococcygeus and pubrectales, which in dissection, are practically indistinguishable from one another. These fibers form a strong bifurcated sling which extends from the pubis in front to the coccyx behind. From the perineal body to the pubes, its two limbs bound the genital hiatus and are in direct relation with the vagina, the base of the bladder and the beginning of the urethra. They are also related to the upper surface of the urogenital diaphragm and are strongly supported by it. By contraction of this musculature, the pelvic floor is raised as a whole, the anal canal is drawn upward toward the pubes, a strong sphincteric action on the vagina manifests itself, and the bed or platform upon which the bladder and the first part of the urethra rest are elevated. Further, it should be remembered that no matter by what means the viscera are suspended, this floor forms the ultimate foundation upon which they lie. It is therefore the only true support, while the other structures, which in ordinary parlance are referred to as supports, are in reality suspensories.

A portion of the levator ani muscle not ordinarily described in textbooks is that small but very important segment which is attached to the urethra to form a strong voluntary sphincter. It is located just anterior to the involuntary internal urethral sphincter; it is U-shaped, and by its contraction brings the posterior urethral wall up against its anterior wall, thereby

angulating it and creating a strong sphinctoric effect.

According to Hinman, a successive series

*The Urogenital Diaphragm.* In the female, the urogenital diaphragm or triangular ligament is a strong, dense, fibrous

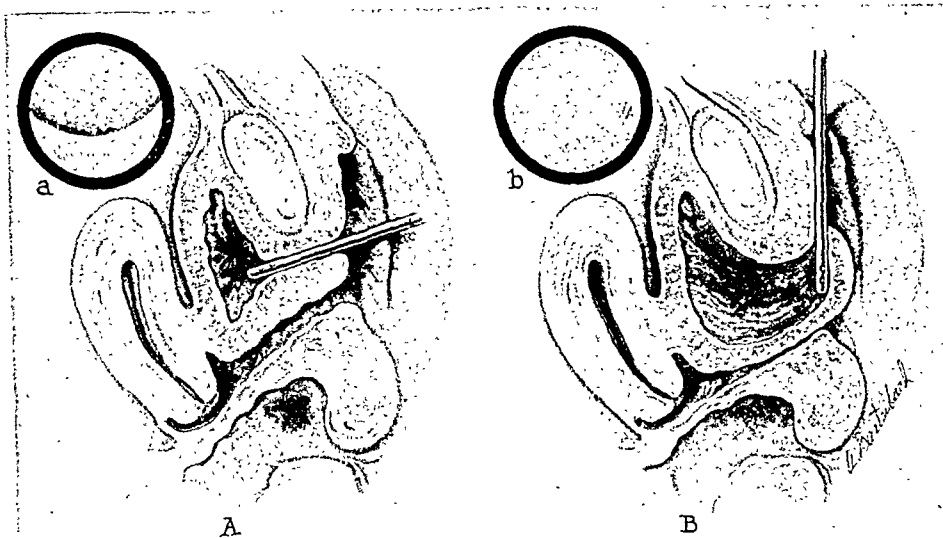


FIG. 4. A, normal bladder and urethra. Catheter describes a 45 to 50 degree angle with the horizontal upon insertion. a, cystoscopic view obtained in normal urethrovesical anatomical status and relationship. B, cystocele and urethrocele, illustrating the anatomical departure from the normal. Inserted catheter assumes a 90 degree angle with the horizontal. b, cystoscopic view obtained in cysto-urethrocele.

of voluntary loops are sometimes thrown about the entire length of the urethra by the levator, and these act as multiple sphincters. However, they are evidently not constant, as dissections and histological studies do not always disclose them.

Because of the anatomical facts above described, a properly executed operation for the cure of urinary incontinence should include the plication of the peri-urethral levator fibers in order to angulate or tighten the tube postero-anteriorly. Furthermore, a subvaginal approximation of the attenuated pubococcyge and their overlying fascia at the same sitting serves to take up the slack in the pelvic floor, thereby raising and strengthening the foundation which supports the vesical fundus and first part of the urethra. In addition, since the urethral levator sphincter is derived from the pubococcygei, a well executed perineorrhaphy must of necessity further tighten this sphincter, and therefore greatly aid in abolishing the condition of incontinence.

and muscular structure. It extends from a point immediately behind and below the arcuate ligament of the pubes to the anterior margin of the ischial tuberosity on either side, and has a strong attachment to the inner aspect of the ischiopubic rami. Medially, it is continuous with the walls of the urethra and vagina, and it is continued directly into the perineal body posteriorly. By this means these three structures indirectly gain firm attachment to the bones. In addition, the vesical base is well supported by it.

This entity, then, forms a strong support for the anterior part of the pelvic floor from the pubes to the perineal body. This corresponds to that space which is left by the divergence of the levator bellies as they pass backward from the pubes, the so-called genital hiatus. It is thus a means of strengthening and supporting the floor of the pelvis at this point of weakness.

In structure the diaphragm consists of three layers, namely, a sheet of fascia on either surface with a layer of muscle

between. The superficial or inferior fascia is strong and fibrous. It is regarded as being in the same morphological plane as the

clude the plication of the peri-urethral fibers of the sphincter urethrae muscle. Further, during routine repair of the

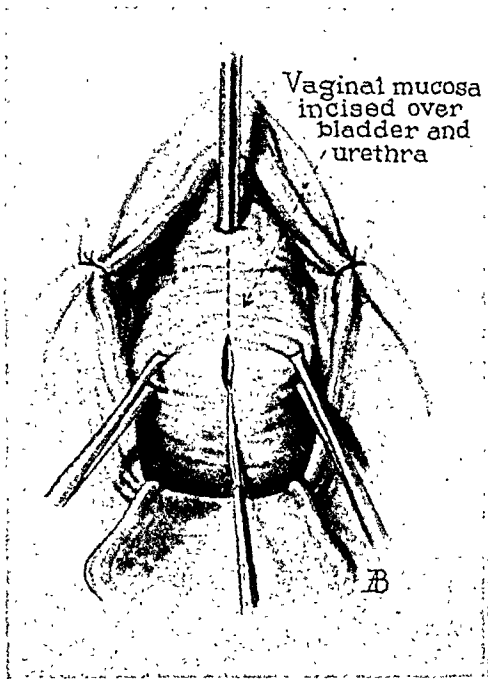


FIG. 5. Initial incision over crest of cystocele with catheter in situ. Incision is extended upward to urethral meatus, and downward to the cervix.

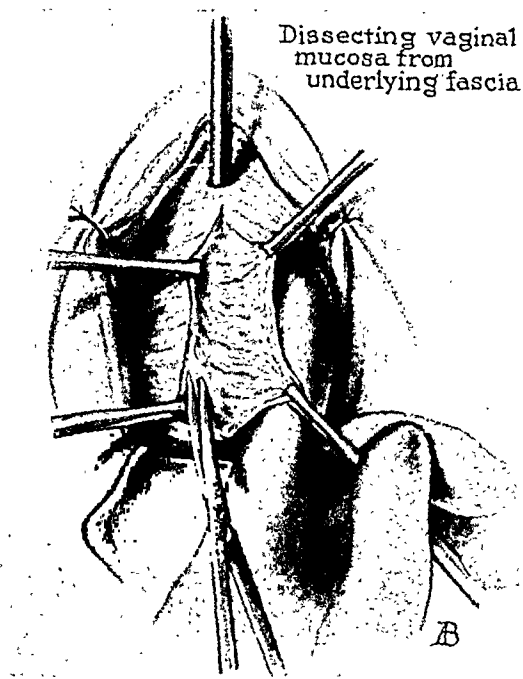


FIG. 6. Separation of anterior vaginal wall from bladder. Sharp scissors dissection removes pubocervical tissue from vaginal wall and allows it to remain on presenting surface of vesical fundus.

bony and ligamentous pelvic wall, that is, as a part of that wall developmentally. The deep or superior fascia is in reality merely a portion of the obturator division of the parietal pelvic fascia prolonged and reflected antero-inferiorly.

The muscles in the diaphragm are the deep transverse perineal, and the sphincter urethrae, both derived embryologically from the cloacal sphincter. The former stretches across the pelvis between the two ischial tuberosities, while the fibers of the latter course upward and inward to surround a segment of the urethra just anterior to the levator sphincter. Since the sphincter urethrae muscle surrounds the entire periphery of this portion of the urethral tube, the voluntary contraction of its fibers must necessarily narrow its lumen in a circumferential manner.

The properly performed operation for urinary incontinence, therefore, must in-

lacerated perineum, the posterior border of the urogenital diaphragm should be identified if possible, and made taut by reefing or plication. This maneuver will aid in no small measure in the restoration of urinary continence, in the firmer anchorage of the urethra, as well as in the reinforcement of the genital hiatus.

*The Bulbocavernosus Muscle.* The bulbocavernosus muscle, or sphincter vaginae consists of two halves which are placed one on either side of the vestibule. It is of the voluntary variety and is situated in the superficial perineal compartment, covered by Colles fascia, and resting on the inferior fascia of the urogenital diaphragm. Posteriorly the fibers of each side meet in the perineal body and are attached to the central tendon of the perineum. Anteriorly, the two portions of the muscle become narrower, and, converging toward the

midline, are attached to the sides of the clitoris, and arch over the anterior urethral wall in the manner of an inverted "U."

ing structures. The cervix does not change its level anteriorly or posteriorly. The external os, though fully dilated, retains

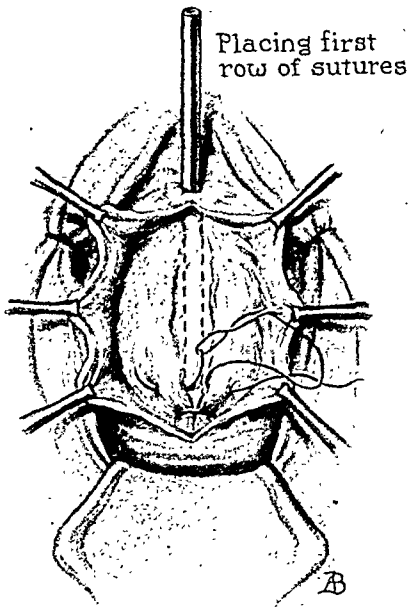


FIG. 7. Plication of pubocervical tissue plane with catheter still in situ. Number of rows of sutures placed depends upon amount of relaxation present.

The latter situation allows for the compression of the anterior wall of the urethra against its posterior wall during contraction of the muscle, in direct opposition to the action caused by the contraction of the levator sphincter at the vesical end of the urethra.

When operating for the cure of incontinence, a proper anatomical repair should include the suturing of the stretched or lacerated bulbocavernosus fibers which are found peri-urethrally. In addition, the retracted posterior ends of the muscle should be sought after and restored by suture during performance of the perineorrhaphy.

#### MODUS OPERANDI OF LABOR IN THE PRODUCTION OF INCONTINENCE

The cervix being fully dilated, the passenger must pass down through the vagina, slowly dilating it and the surround-

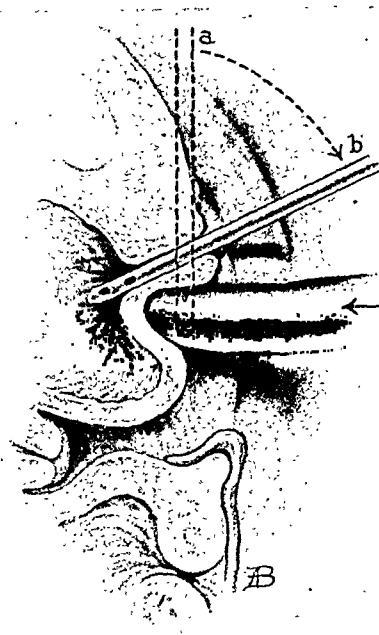


FIG. 8.—Manipulation of catheter from within vagina to produce a normal urethral angle.

its general relations to the plane from the symphysis to the coccyx, expanding to the diameter of the pelvis, but neither ascending or descending as far as its bony relationships are concerned.

The bladder rises above the symphysis, but only in its flattened and stretched upper part. This organ is long and narrow and the position of those parts attached to urogenital diaphragm are not altered. The urethra retains its position as does the lower portion of the vagina. The lower part of its pubic segment cannot move, for it is firmly anchored by the urogenital diaphragm to the ischiopubic rami. The loose bladder may be pulled or squeezed up, but the parts supporting the base of the bladder and first portion of the urethra remain to be stretched, contused, or lacerated by the descending head. The urethrovesical platform is thus broken down, and the urethral sphincters are stretched and distorted, while, at the same time, their normal angle is greatly altered.



If the fetus comes through slowly and gently, the muscular and fibrous tissues, softened by the processes of pregnancy and

tions, it may safely be stated that no pelvis remains normal after it has once been subjected to the inevitable injury

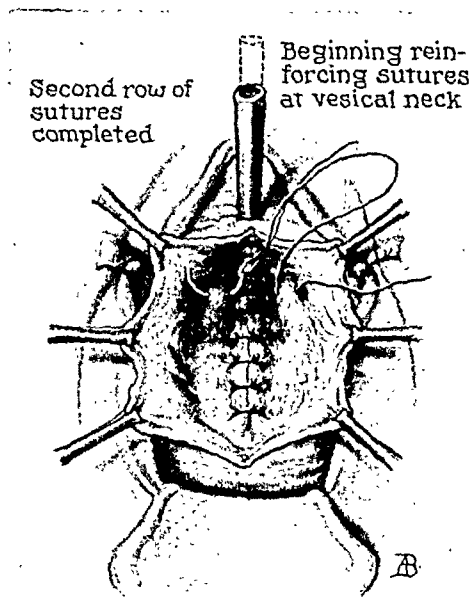


FIG. 9. Beginning reinforcing sutures at vesical neck. Subsequent sutures are placed along the entire length of the urethra up to the external meatus.

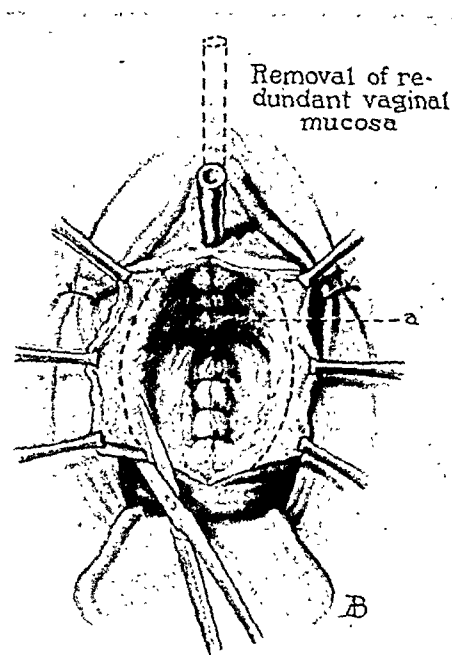


FIG. 10. Peri-urethral sutures shown in place (a), and catheter assuming a normal angle with the horizontal. The redundant vaginal mucosa is excised.

labor, gradually dilate and allow it to pass. However, if undue force is employed either by the powers or by the obstetrician, these supports are weakened to a greater or less degree. Further, the question of the duration of the particular labor, the existence of any cephalopelvic disproportion with its usual attendant compression of nerves and vessels (leading to trophic and nutritional disturbances of the supporting elements), must necessarily be a prime factor in the future anatomicophysiological status of the viscera under consideration.

It is unfortunate that almost every labor, regardless of how scientifically conducted, produces greater or lesser amount of injury to the pelvic supporting structures. To what degree restitution to normal will occur, depends of course upon the degree of damage produced, plus the great factor of tissue restorative abilities of the individual patient. With very few excep-

produced by the downward passage of a full term fetus. Repeated labors aggravate the original damage.

Since the bladder and urethra are subject to direct compression during labor, and their supports, nerves, vessels, and sphincter mechanisms injured, it is little wonder that so many women suffer the condition of urinary stress incontinence subsequent to childbirth. That surgery for this condition is necessary, goes without saying.

#### PREOPERATIVE MANAGEMENT

In addition to the usual régime employed preparatory to all vaginal operative procedures, we lay particular stress upon the condition of the urine and bladder. Since most of the patients with "true operative incontinence" have an associated low grade bladder infection, and many of them have experienced repeated attacks

of acute cystitis, we routinely culture the urine.

Mandelic acid, the sulfonamides, and in alkaline infections, irrigations of the bladder with sterile citric acid titrated to a hydrogen ion concentration of 4 are employed in the case of lower tract involvement. If a virulent organism is found on culture, the upper urinary tract is investigated, and penicillin used if a Gram-negative bacillus is not the offending organism. We never attempt a surgical repair unless the urine is definitely clean.

#### SURGICAL TECHNIC

A light weighted piece of metal tubing or plastic rod with a No. 16 F. size may be placed in the bladder. We suggest the use of a light weighted metal catheter of this calibre. It will be noted that in the "true operative cases," the vast majority of which have a combined urethrocele and cystocele, this tubing will approximate an angle of 90 degrees with the horizontal upon insertion.

Next, a longitudinal incision is made in the anterior vaginal wall extending from the external urinary meatus to the cervix. The subsequent separation is facilitated by beginning the incision at the crest of the cystocele when the latter is present, and then extending the incision superiorly to the external urethral opening and inferiorly to the cervix.

In those infrequent cases in which the urethrocele is unaccompanied by a cystocele, it is still much more advantageous to start the initial incision over the bladder for two reasons: first, because no cleavage plane exists between the anterior vaginal wall and the urethra, while a plane is present between the anterior wall and bladder; and secondly, we are of the opinion that mobilization of the bladder with subsequent advancement and plication of the pubocervical tissue plane helps to rebuild the damaged urethrovesical platform, irrespective of the presence of a clinical cystocele.

After the vaginal incision has been made,

sharp scissor dissection is used in the mobilization of the bladder, being certain to leave as much of the pubocervical tissue

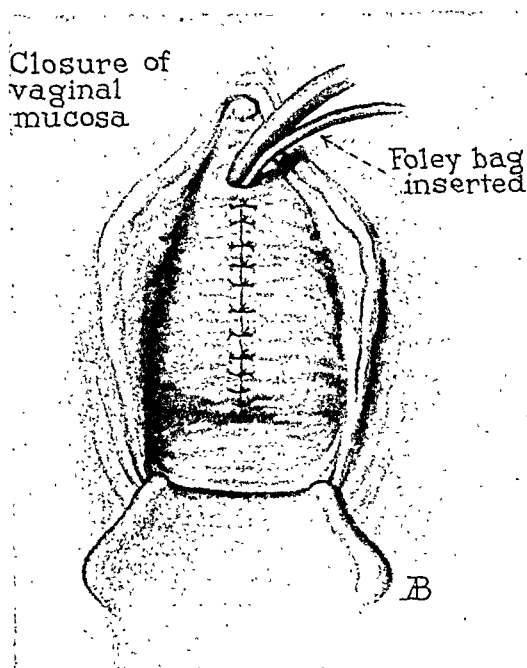


FIG. 11. Completed operation with anterior vaginal wall sutured. Metal catheter is removed and Foley bag inserted into bladder.

as possible attached to the wall of the vesical fundus, and keeping the vaginal wall devoid of it, as the excess of the latter will subsequently be discarded. Further, this maneuver acts as a prophylactic measure in protecting the bladder wall from injury during the suturing which is to follow.

After complete mobilization of the bladder and urethra, the flexor surface of the index finger is placed against the catheter from within the vagina and the catheter gently stroked from above downward. The initial point at which the catheter is found to assume an angle of 45 degrees with the horizontal is designated as the urethrovesical junction. It is at this point that we are desirous of building up an integral portion of the platform which will enable the catheter to maintain this angle permanently.

The pubocervical tissue is next plicated in the midline, beginning near the cervix and extending upward to the urethrovesical

junction, employing interrupted fine silk sutures. We are careful not to stray from the midline, and to place our sutures only through the pubocervical tissue, avoiding the actual bladder wall. By making this axiomatic, we minimize the possibility of fistula production plus the inclusion of the juxtavesical portion of the ureters in our sutures. Further, by employing this technique, the repair involves only the trigone as to elevation, and does not distort its anatomy, especially as to boundaries. In fact, the normal distance from the interureteric ridge to the vesical neck is restored, the ureteral orifices are brought back to their normal relationships with the urethra, the distorting influence of the cystocele bulge on the posterior wall of the urethra is eradicated, and the urethral sphincters are once again made to assume a normal angle. A new urethrovesical platform is thus also created.

By ignoring the pubocervical tissue and placing the sutures directly into the bladder muscularis, as is indeed frequently done, the normal angle of the sphincters are restored. However, there can be no restoration of the urethrovesical platform, and the bladder trigone might be endangered. An operative shortening of the distance from the interureteric ridge to the vesical neck would tend, on healing, to produce frequent spasms and irritation of the neck, with marked urgency and tenesmus, and possibly act as a factor in initiating a subsequent paradoxical incontinence.

The number of rows of sutures employed depends upon the size of the cystocele, but we do place at least one row even though no bladder relaxation is apparent. We then place sutures, and if we deem it necessary, reinforcing sutures at that point where the catheter is made to assume the 45 degree angle with the horizontal.

The next step is the placing of fine interrupted silk sutures from the external meatus down to the vesical neck. This is accomplished with the catheter still *in situ*, and upon completion of this suturing the

diameter of the urethra will approximate 16 F., with a restoration of its normal circular contour. By this maneuver the urethral sphincter fibers of the bulbocavernosus, the sphincter urethrae muscle which lies within the layers of the urogenital diaphragm, the urethral sphincter fibers of the levator ani, and the involuntary internal urethral sphincter are successively plicated and shortened. In addition, the urethra, which during micturition normally should approach a No. 14 F. calibre, is approximated to a No. 16 F. calibre so that a No. 2 F. compensation exists for the contraction of scar tissue subsequent to the repair.

The redundancy of anterior-vaginal wall is now excised, and the residual portion brought together with fine interrupted chromic catgut, thereby creating a firmer floor for the vaginal portion of the urethra.

The catheter is then removed, and a No. 16 F. Foley bag inserted into the bladder. We prefer this bag to a mushroom catheter because there is much less trauma upon its removal, and it better protects the site of repair from injury.

The performance of a routine perineorrhaphy is the final step in the operation. By taking up the slack in the pubococcygeal bellies of the levatores and their overlying fascia, the supporting foundation upon which the bladder and urethral suspending structures rest is elevated and made taut. Indirectly, therefore, the slack is taken up in the pubocervical tissues, the tendinous arches, pubovesical ligaments, and neurovascular bundles, and as a consequence, the bladder and urethra are more firmly slung and suspended in the pelvis. Further, an indirect tightening effect manifests itself on the previously repaired urethral sphincter fibers derived from the levatores.

If also during routine execution of the perineorrhaphy the posterior retracted edges of the urogenital diaphragm and bulbocavernosus muscle can be identified, these should be reefed or plicated. This will manifest itself in an indirect tightening

effect upon the sphincter urethrae muscle, and the most external of the sphincters, that derived from the bulbocavernosus, both of which were directly shortened and tightened during a previous step in the technic.

#### POSTOPERATIVE MANAGEMENT

In addition to the usual postoperative treatment, daily or twice daily bladder irrigations through the Foley bag are carried out. Potassium permanganate 1:10,000 solution is employed, and in those cases in which alkaline infections were found, irrigations with sterile citric acid titrated to a hydrogen ion concentration of 4 is used. Also, mandelic acid or the sulfonamides are administered by mouth if deemed necessary. The Foley bag is left *in situ* for seven or eight days, and after its removal, the patient is allowed out of bed, and she is usually discharged on the tenth day postoperatively.

An exceedingly important point in the late postoperative care, which we never fail to include, is to impress upon the patient the need for returning about three weeks after performance of the surgery. At this time the urethra is dilated, using ordinary Hegar urethral dilators. This is done in order to alleviate bladder spasms, and also to stretch the always overcontracted scar tissue which forms about the urethra.

#### SUMMARY

1. Urinary stress incontinence in women occurs frequently enough to merit our serious attention.
2. The high incidence of recurrence of the condition subsequent to attempted surgical correction indicates that the problem has heretofore not been properly attacked.
3. A plan for the diagnosis of "true operative cases" and the exclusion of "non-operative" etiologies by proper history taking, laboratory procedures, and

combined gyno-urological workup is advocated.

4. The urethrocytoscopic findings in the normal female, as well as those in cases of cysto-urethrocele are described.

5. The detailed and applied anatomy of urethrovesical suspension and support is set forth.

6. A suggested new operative technic is described and the rationale for each step stated.

7. Our preoperative, as well as early and late postoperative treatment is offered.

8. Accompanying illustrations are presented for the purpose of clarifying the subject matter.

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# PHTHALYLSULFATHIAZOLE-'SULFATHALIDINE'

## A CLINICAL EVALUATION IN 122 PATIENTS WITH PROCTOLOGIC AND RELATED CONDITIONS

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THE value of preoperative and post-operative administration of certain of the sulfonamides to patients subjected to intestinal and colonic surgery, as an adjunct to careful surgical technic, has been emphasized by numerous investigators,<sup>1-13</sup> and the routine use of these intestinal bacteriostatic agents has become a recognized clinical procedure. Since its introduction by Poth<sup>1</sup> and by Firor and Poth<sup>2</sup> in 1941 succinylsulfathiazole has been preferred by many surgeons because of its marked effectiveness in reducing the number of pathogenic coliform organisms in the lower intestine and colon, thus reducing the incidence of peritonitis following extensive surgical intervention or accidental soilage.

Rosser and Kerr,<sup>3</sup> in discussing the preoperative administration of succinylsulfathiazole, are of the opinion that, "until a more effective agent is available, no individual should be subjected to extensive surgical procedures on the intestinal tract without having had the benefit of this protective therapy." Although succinylsulfathiazole probably was the best compound at our disposal, the administration of this so-called slightly absorbable sulfonamide was attended by certain limitations, the modification or elimination of which was considered most desirable. This drug induces the formation of a semiliquid stool which presents disadvantages in the performance of certain proctologic procedures which involve the perineum, anus and rectum. Its action according to Poth and his associates<sup>4,5</sup> and in view of our own experience, is adversely affected by the presence of diarrhea or relatively severe

constipation. Although not serious, patients often object to the relatively large dosage required. The experience accumulated since the introduction of sulfonamides during the last decade indicates that some degree of toxicity or development of sensitivity is to be anticipated on administration of any compound of this class, but the clinician anticipates also the development by his research associates of a compound which minimizes such a possibility and which, in this particular field, modifies or eliminates the somewhat unfavorable characteristics and limitations noted above.

In 1943, a new sulfonamide, phthalylsulfathiazole, was reported to possess certain properties which appeared to present more desirable characteristics and less limitations of use, in the surgical field at least, than did succinylsulfathiazole, to which it is chemically and pharmacologically related.<sup>14-18</sup> The clinical use of phthalylsulfathiazole in surgery has been reported by Poth and his associates,<sup>19-21</sup> and was mentioned by Bacon and his co-workers.<sup>22</sup> These studies indicated that phthalylsulfathiazole effects a more rapid reduction of *Escherichia coli*, vegetative forms of the clostridia and related organisms in the feces than does succinylsulfathiazole; that the feces become soft but that a diarrhea or semiliquid stool is not produced; that it is effective even in the presence of a watery diarrhea; that it is poorly absorbed from the intestinal tract; that little or no toxicity has been observed and that the dose in comparison with succinylsulfathiazole is relatively small.

During the past year an opportunity has

been presented to evaluate phthalylsulfathiazole\* with respect to its use in the treatment and control of conditions commonly encountered in the practice of proctology. The description of the results obtained in patients to whom this drug was administered as included in this report is that of an unselected series, which represents 122 consecutive cases encountered in private and dispensary practice.† More than 90 per cent of these patients (112) were subjected to surgery and the remainder (10) were treated medically. The latter group is small and probably not significant in this series but is included because of certain points of interest and for completeness.

The following are the types and number of cases to which phthalylsulfathiazole was administered surgically and medically:

| Phthalylsulfathiazole Administered before and after Operation   | No. |
|---|-----|
| Hemorrhoidectomy (external and/or internal)                     | 42  |
| Excision of fissure-in-ano (chronic and acute)                  | 28  |
| Fistulectomy  | 18  |
| Resection of colon (neoplasm)                                   | 10  |
| Cryptectomy and papillectomy                                    | 3   |
| Excision of pilonidal sinus                                     | 3   |
| Incision and drainage of ischiorectal abscess                   | 3   |
|   | 107 |
| Phthalylsulfathiazole Administered after Operation              |     |
| Resection of small bowel (93 cm.) (acute mesenteric thrombosis) | 1   |
| Laparotomy and drainage (ruptured diverticulum of sigmoid)      | 1   |
| Laparotomy and lysis of adhesions (acute diverticulitis)        | 1   |
| Appendectomy and lysis of Jackson membrane                      | 1   |
| Laparotomy (exploratory) and appendectomy                       | 1   |
|   | 5   |
| Phthalylsulfathiazole Administered Medically                    |     |
| Ulcerative colitis  | 7   |
| Infectious diarrhea (postpartum)                                | 1   |
| Mucous colitis  | 1   |
| Severe pruritis ani   | 1   |
|   | 10  |
|   | 122 |

Phthalylsulfathiazole first was administered on the basis of 0.05 Gm. per kilogram of body weight. The initial dose was

\* "Sulfathalidine" phthalylsulfathiazole was provided in generous quantities for the purpose of this investigation by the Medical-Research Division of Sharp & Dohme, Glenolden, Pa.

† Since this article was written, J. A. Bargen reports favorably on Sulfathalidine in Intestinal Disease.<sup>24</sup>

followed in four hours, and each four hours thereafter, by a maintenance dose calculated on the same basis as the first dose and divided in equal parts for administration over a twenty-four hour period. In most instances the 4:00 A.M. dose was omitted and that increment added in equal parts to the 12:00 midnight and 8:00 A.M. doses. Later it was found desirable to increase the dosage to 0.1 Gm. per kilogram of body weight in order to bring about a more rapid alteration of the intestinal bacterial flora and to maintain this effect. In a short time it became apparent that the optimal dosage for our purpose was in most instances approximately 5 Gm. daily in three or four equally divided doses following an initial dose of 5 Gm.

The patients on whom anorectal surgery was contemplated received their initial dose of phthalylsulfathiazole twenty-four hours prior to operation and the medication was continued thereafter for ten days to three weeks following operation, dependent upon the extent of the surgical procedure and the progress of wound healing. The drug was administered to patients being prepared for bowel surgery for from three to five days prior to operation. As soon as these patients were able to retain an ounce of water subsequent to operation, administration of phthalylsulfathiazole was resumed as before. The drug was given also to the patients with acute conditions as soon after operation as possible.

In no instance was it necessary to interrupt the course of medication because of the appearance of toxic manifestations. In only a few instances slight anorexia and nausea were observed and in two others vomiting occurred. One of the latter, a highly neurotic patient, experienced considerable postoperative vomiting. As orders were about to be given to stop the drug, the patient volunteered the information that she "always vomited after an operation and only an intravenous injection stopped it." Physiologic saline was administered immediately and phthalylsulfathiazole was continued. The vomiting

ceased and the patient proceeded to a normal convalescence without further difficulty. No renal complications or symptoms of any kind were observed during medication with phthalylsulfathiazole. This latter fact, together with the lack of toxic symptoms or signs in general, was anticipated in view of the poor absorption of the drug as reflected by the free and conjugated sulfonamide blood levels, determined by a modification of the method outlined by Bratton and Marshall.<sup>23</sup>

The free and conjugated sulfathiazole blood levels remained low, ranging between 0.2 to 3.0 mg. per 100 cc. of blood for the free and 0.7 to 3.0 mg. per 100 cc. of blood for the conjugated level. There were two cases in which the conjugated level reached 6.0 mg. The sulfonamide determinations were made at various times throughout the postoperative course of treatment. With few exceptions little difference is noted between the blood levels of patients who received 2 Gm. of phthalylsulfathiazole daily and those who received larger doses. The blood levels following administration of phthalylsulfathiazole in this series are comparable to those reported by Poth and Ross,<sup>21</sup> and the occasional high levels probably are due to absorption of the drug through granulating surfaces as stated by these authors.

One of the most gratifying observations noted in this series is the remarkable reduction in the number of patients to whom it was found necessary to administer purgatives preoperatively in order to clean the bowel, and enemas and purgatives postoperatively to initiate normal bowel movements. Patients subjected to anorectal surgery usually experienced a normal bowel movement on the second or third postoperative day with a minimum of effort and discomfort. It is believed that this occurred because the stool had become soft and gelatinous and most of the bulk had been lost. Because of the reduction, or in some instances, the elimination of the majority of pathogenic organisms in the feces, postoperative complications, such

as abscess, anal stricture, postoperative hemorrhage and trauma due to administration of enemas, were not encountered, and, as a result, the postoperative disability was diminished considerably. Spontaneous bowel movements were observed also in patients subjected to large bowel resection and in this series one patient had a normal spontaneous bowel movement on sixth day following an end-to-end anastomosis after removal of an adenocarcinoma of the sigmoid.

In this connection it should be mentioned that primary end-to-end anastomosis can be performed, the indications for the Mikulicz operation lessened and in general more aggressive surgical intervention can be successfully executed when the patient is properly prepared with an adequate dose of phthalylsulfathiazole. In addition, the postoperative discomfort, general disability and period of convalescence are reduced to a minimum.

The administration of phthalylsulfathiazole for preoperative preparation for large bowel surgery has proved to be exceptionally advantageous. It has been observed that the administration of this drug to patients with a neoplasm in the large bowel who have definite signs and symptoms of intestinal obstruction are often relieved of distention and pain and they will frequently have a normal bowel movement. In this way acute obstruction is avoided or at least delayed until the patient is in better condition to withstand extensive surgical resection. In some way the drug seems to break up the fecal impaction which precipitates the onset of acute obstruction and the stool is changed to a soft gelatinous mass with little bulk. The drug, perhaps by reason of the free sulfathiazole produced by hydrolysis, reduces or brings under control the secondary infection in and around the neoplasm, thus reducing the edema which usually accompanies an inflammatory process. The lumen of the bowel may become widened thereby, and it may be restored to more nearly normal function. This permits better

preparation of the patient for whatever surgical procedure might be indicated.

In the ten patients subjected to large bowel surgery in this series, the results were exceptionally good. In one bleeding occurred on the fourth postoperative day and the drug was stopped. Although it is not apparent from a review of this particular group of cases, it has been our observation and that of our associates bleeding or hemorrhage from a neoplasm occurs only rarely when phthalylsulfathiazole is administered. This is in contrast to our experience with succinylsulfathiazole, since we have observed such bleeding in from 10 to 25 per cent of patients with neoplastic growths in the colon to whom this drug had been administered. Usually the bleeding is not serious with either compound and the drug may be continued, but in certain instances it becomes necessary to stop administration of the sulfonamide entirely. It may be resumed, however, as soon after operation as possible if a resection has been performed or if a colostomy is made.

In a small series of patients subjected to emergency operative procedure, five of which are reported here, the postoperative administration of phthalylsulfathiazole has appeared to be of definite advantage. Because of its rapid action in reducing the number of coliform and other gas-producing organisms, convalescence is made easier by reason of the reduction in distention with its concomitant discomfort to the patient, and the operative wound heals more rapidly. Especially favorable results were obtained in two patients with acute diverticulitis that developed severe diarrhea and cramps postoperatively. The development of a marked distention with its concomitant serious consequences was greatly relieved in another patient, on whom a resection of 93 cm. of small bowel was performed subsequent to an acute mesenteric thrombosis.

Phthalylsulfathiazole was administered to a small series of patients with ulcerative colitis and also three patients with other

complaints commonly encountered in a proctologic clinic. These are included for the sake of completeness and because it appears that the drug is of some benefit in the treatment and control of ulcerative colitis. Seven cases of ulcerative colitis are here reported: five acute fulminating, one chronic ambulatory, and one intractable case with an ileostomy. The usual supportive measures generally recommended for patients with ulcerative colitis were carried out in addition to administration of the indicated dosage of phthalylsulfathiazole. Among five patients with acute fulminating ulcerative colitis\* the results were excellent in three, good in one, and poor in one. The results were determined by the reduction in bowel movements, disappearance of blood from stools, and loss of toxic symptoms. All of the patients in this group were maintained on small daily doses with the thought in mind that acute exacerbations of the disease would be avoided or markedly reduced in number. All patients were observed carefully for the development of toxic reactions but none were noted. One of these patients has taken the drug daily for twelve months and has volunteered the information that he has felt better than ever before. Only an occasional and very mild exacerbation of the disease has been experienced during the time this patient has been under treatment with phthalylsulfathiazole.

In this series, also, is included a boy sixteen years of age who had an ileostomy performed at the age of twelve years, because of an extremely fulminating ulcerative colitis. During the succeeding four years frequent acute exacerbations occurred with loss of weight, constant suppurative drainage from the rectum and other serious and annoying developments for which no therapy was effective. A total colectomy was being considered at the time when daily irrigation with a suspen-

\* Acute fulminating is here considered one that reveals severe systemic reactions, as fever, leukocytosis, increased sedimentation rate, purulent rectal discharge, and marked prostration.



sion of phthalylsulfathiazole through the distal loop was initiated. Within two weeks the improvement in this boy was most remarkable. His temperature became normal, suppurative drainage from the affected bowel ceased and ulcerations of the mucous membrane and the inflammatory polyps previously observed were diminished noticeably. His improvement has continued with daily administration of phthalylsulfathiazole through the distal loop during the past ten months. No toxic effects have been noted and the last sulfonamide blood level was reported as being too low to read.

Poor results were noted in mucous colitis and in pruritis ani. This is to be expected since it is generally accepted that the etiology of these conditions is not wholly of an infectious nature. The one case of acute diarrhea, postpartum, probably caused by a specific organism, certainly is not significant, but the favorable end result might indicate that an investigation of the drug as a remedy for this type of condition might prove to be of value.

#### SUMMARY AND CONCLUSIONS

The new sulfonamide, phthalylsulfathiazole, has been administered to a series of 122 patients with conditions commonly encountered in a proctologic clinic with the following results:

*I. Dosage and Method of Administration.* The average effective dose was found to be about 5 Gm. daily, administered in three or four equally divided doses following one initial dose of 5 Gm.

In anorectal surgery phthalylsulfathiazole was administered twenty-four to forty-eight hours prior to operation. In large bowel surgery it was given three to five days prior to operation.

The drug was started postoperatively as soon after operation as possible and continued for ten days to three weeks depending upon individual circumstances and the progress of healing of the wound.

*II. Toxicity.* The sulfonamide blood level remained quite low when 2 to 5 Gm.

were administered in three or more equally divided doses daily.

Toxic reactions were negligible, only slight anorexia, nausea, and occasionally vomiting were noted.

It should be emphasized, however, that phthalylsulfathiazole is a sulfonamide drug and that toxic reactions are likely to occur if it be administered to patients who have acquired a sensitivity to this class of compounds. The administration of phthalylsulfathiazole probably should be withheld or at most the drug should be administered very cautiously to patients with a history of sulfonamide sensitivity.

*III. In Ulcerative Colitis.* A small series of patients with ulcerative colitis appeared to derive considerable benefit from administration of phthalylsulfathiazole in that the drug improved their general well being, reduced the number and severity of acute exacerbations and appeared to control or arrest the disease process.

*IV. Reduction of Infection in Bowel Surgery.* Because phthalylsulfathiazole greatly reduces the number of pathogenic coliform organisms in the lower intestine and colon, the incidence of peritonitis due to accidental soilage is greatly reduced. Thus, the primary end-to-end anastomosis can be performed without high incidence of serious complications, and that indications for the Mikulicz operation are greatly lessened.

*V. Postoperative Convalescence.* The use of the drug postoperatively in patients subjected to emergency intestinal surgery appears to be of definite advantage in causing a more normal convalescence.

In the preparation and postoperative care of patients in this series, the necessity for use of purgatives and/or enemas was markedly reduced. The bowel became clean and the stool became soft and gelatinous. Distention and postoperative discomfort were reduced to a minimum and spontaneous bowel movements occurred early. Healing of the wound occurred promptly and postoperative disability and complications were decreased greatly.

This study could not have been completed without the cooperation and efforts of the Laboratory Staff of the Cambridge Hospital where all determinations were done. Service cases in this study were from the Surgical Services of Drs. Horace P. Stevens, Edward Cooney, and David Rose of the Surgical Staff of the Cambridge Hospital. To these men and many others who referred private cases for this study, grateful acknowledgement is made.

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# A METHOD OF TREATMENT FOR PILONIDAL SINUS\*

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**P**ILONIDAL sinus is an abnormal opening in the skin superior to the anus, in the gluteal cleft over the sacrum and coccyx. The defect is lined with epithelium and usually contains cellular debris, sebaceous material, and hair. It gets its name from two words—"pilo," meaning hair, and "nidus," meaning a nest. Either an infected foreign body or an embryonic cavity may give rise to a sinus. This lesion contains both causes.

Within the past two years a voluminous literature has accumulated on the subject of pilonidal sinus. This is due to the commonness of the lesion in the personnel of our armed forces as well as in the civilian population. Every phase of the subject has been adequately covered, and the references given may be consulted for: a historical review of the literature,<sup>1,2</sup> embryological factors in the causation of the anomaly,<sup>1,2</sup> its pathology including complications,<sup>3</sup> and its treatment.<sup>4-14</sup>

This article is a discussion of the fundamental factors concerned with the cure of the defect and a description of a satisfactory surgical method for eliminating this minor yet disabling lesion.

In evaluating the advantages of any plan of treatment two important requirements must be considered: First and foremost the percentage of cures by the method, and second, the length of time or disability required to produce the cure.

Almost all authors are agreed that recurrence and disability may reach a minimum by adhering to the following important principles: (1) complete excision of the lesion; (2) avoidance of trauma in performing this task; (3) accurate hemostasis; (4) obliteration of dead space; (5)

avoidance of tension on suture lines; (6) exact approximation of wound edges, and (7) avoidance of infection in the group not already definitely the site of pus formation. These principles are those emphasized in any consideration of wound healing with a minimum of granulation tissue, and we have previously enunciated them under the caption of "factors which delay wound healing."<sup>15</sup>

To accomplish this end most surgeons have divided the patients into two large groups: those which are not primarily infected and those which have large burrowing infected sinuses or abscesses. The former group have been treated by the following methods: excision and primary closure; excision, sulfathiazole implantation, and primary closure; excision, undercutting, the use of fine silk as suture material, and primary closure; excision, formation of flaps, and primary closure; excision, the use of buffered sulfanilimide and primary closure; excision, packing of wound with gauze without closure; marsupialization. In the second group the treatment varies with different surgeons as follows; excision leaving wound wide open and packing with gauze of various types; excision using sclerosing solution, and leaving wound wide open; excision packing wound with sulfonamide powder and leaving the wound wide open; excision, anchoring of the wound flaps to the fascia or anchorage of the skin to the fascia of the sacrum and coccyx; cautery excision and wide open packing.

Results are as variable as the methods of treatment. MacFee<sup>9</sup> reported 53 per cent abscesses and other complications with

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prolonged healing time in thirty-four cases of primary closure. Scott<sup>11</sup> reports 96.4 per cent primary healing in twenty-eight cases

6 per cent by using fine silk and primary closure. In the infected group the incidence of recurrence was reduced from 22 to 4.3

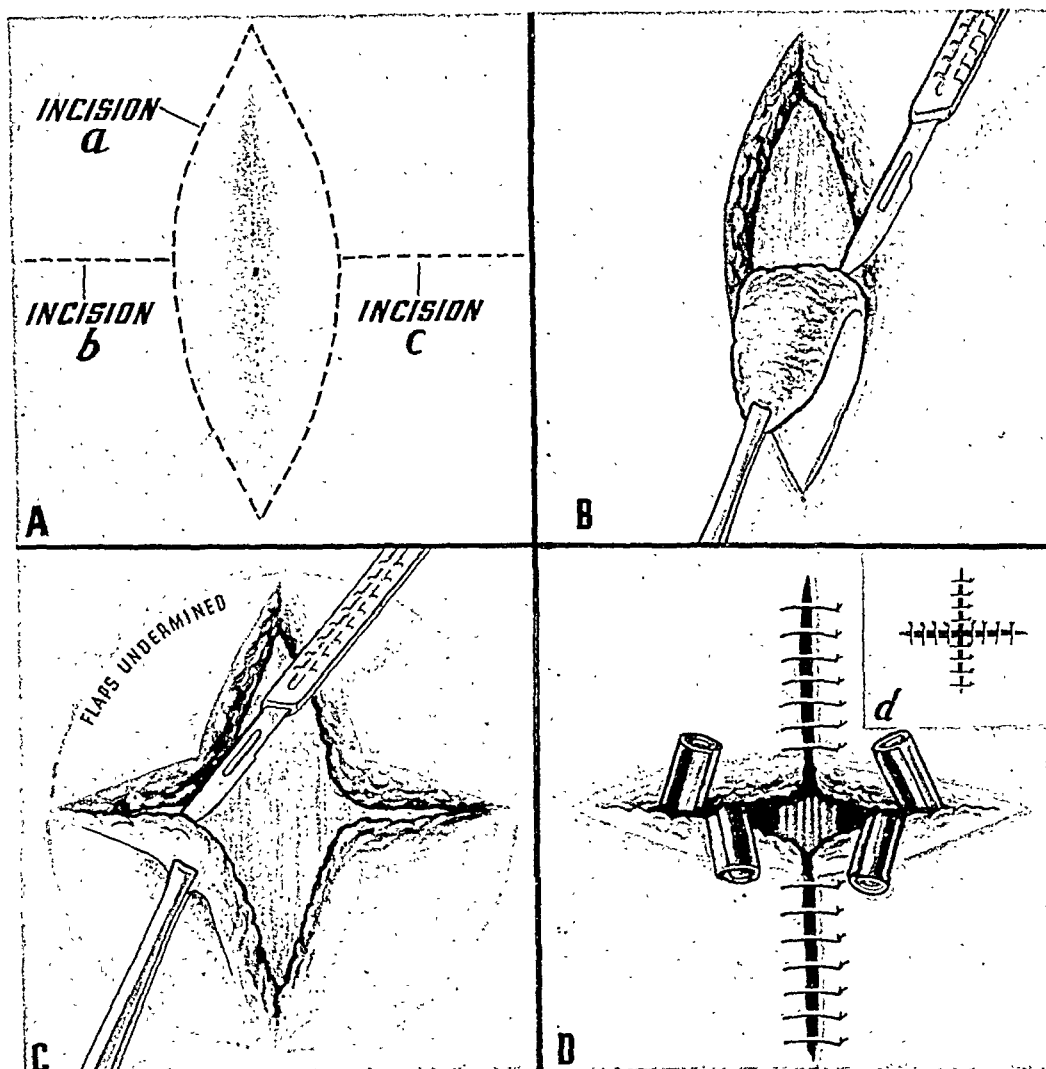


FIG. 1. A, lines of excision and incision in the removal of pilonidal sinuses and their ramifications; B, excision of the primary sinuses; C, undermining of flaps and excision of all subcutaneous channels; D, partial closure with drainage in infected cases; d, primary complete closure. The wound edges are loosely approximated so that subsequent swelling will not produce an ischemia of the suture lines.

with an average hospital stay of 18.8 days. Woldenberg and Sharp<sup>13</sup> report 100 cases of excision and primary closure. Of these, ninety-eight were entirely successful; two had recurrences. Complete healing took place in fourteen days in 72 per cent. Soldiers returned to duty on the twenty-second and twenty-third postoperative days. Dunphy and Matson<sup>10</sup> reduced the incidence of recurrence from 27 per cent to

per cent by using cautery excision and open packing. Buie<sup>14</sup> marsupializes the cyst or abscess wall and reports good results.

A review of the literature impresses one with the fact that results with similar methods differ greatly among the various surgeons reporting. The consensus of opinion seems to be that the safest method to use for the prevention of recurrence is

that of wide open packing, although this necessarily carries the longest disability.

#### TRANSVERSE OR LATERAL INCISION WITH FORMATION OF FLAPS

Our method embodies the fundamental surgical principles necessary for wound healing by first intention. In addition it affords a short period of disability and comparative freedom from recurrence. To accomplish this in clean cases the operative field is scrubbed with soap and water for ten minutes with gauze sponges eight days prior to the operation. The sinus is then excised widely and completely with a minimum of trauma, under 1 per cent procaine local anesthesia. Flaps are fashioned by undercutting and by two lateral incisions as depicted in the diagram. This permits primary closure with no tension and with complete rest to the suture lines even though the patient is ambulatory. The lateral incisions are closed loosely so that drainage may take place and in infected cases they are left open although the longitudinal incisions are closed. Fine chromic catgut No. 000 has been used for the deep suture and silk or cotton for the skin. Sulfonamides have not been given by mouth or used in the wound in the infected or clean wounds.

#### REASONS FOR PROCEDURE

We have previously shown that in the experimental animal, scrubbing of the abdomen eight days prior to surgery increases the resistance of the abdominal wall to infection.<sup>15,16</sup> This we believe to be due to an increase in the local resistance of the part due to the trauma of scrubbing. The formation of flaps as described releases all tension on the longitudinal suture line. Since infection is most apt to occur in the lower portion of the incision, factors were sought which might account for this observation. It was believed that although this area was closest to the rectum and therefore the infected material, yet the constant movement of the flaps by turning in bed or walking or muscle contraction,

delayed healing in this area. By permitting mobility at a higher level the two lower flaps move as a unit and the suture line is therefore put at rest.

The transverse portion of the incision is placed at a higher level so that it is less apt to be grossly contaminated. The incision provides ample drainage and allows the entire area to heal from the bottom up. Moreover it falls together better in the upright than in the recumbent position. This method combines the features of the open operation with those of primary closure and it does not have the probability for complications that primary closure has, nor does it produce the long healing period required for the open operation.

#### RESULTS OF TREATMENT

This procedure has been carried out in ten patients. All were males. The patients were kept in the hospital for an average of four days. The longest healing time was thirty-one days in a badly infected case and the shortest healing time was fourteen days in an uninfected case. Thus far there have been no recurrences.

#### CONCLUSIONS

A surgical method is described for the cure of pilonidal sinus which (1) is easily accomplished, (2) requires a minimum of hospitalization, (3) provides healing in a relatively short time, and (4) is not conducive to recurrences.

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A TENSE anal haematoma, resulting from rupture of one of the anal veins, commonly occurs on the lateral aspects of the anal margin, and it is in this situation that excision of the swelling is most suitably carried out. The operation should be done when the haematoma is single and tense, before the overlying skin has become ulcerated and before the clot has discharged with risk of local infection.

From "Minor Surgery" edited by Humphry Rolleston and Alan Moncrieff (Philosophical Library).

# REFRIGERATION ANESTHESIA

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**R**EFRIGERATION anesthesia may be defined as a type of topical anesthesia resulting from the reduction of local temperature. The use of this type of anesthesia for amputation of the lower extremity has been reported with increasing frequency. To date, however, there have been too few reports comparing the end results of amputation with refrigeration anesthesia and the end results of amputation using other methods of anesthesia. This paper attempts such a comparison. A total of ninety-three amputations are presented. Refrigeration anesthesia was used in twenty-three and other methods of anesthesia in seventy.

## CLINICAL EXPERIENCE

The technic used was similar to that recently reported by Cayford and Pretty and need not be repeated here. Suffice it to state that cracked ice was used to accomplish hypothermia and a tourniquet was used in all cases. In some few cases refrigeration was used primarily for purposes of detoxification. When the latter group is included, a total of thirty patients have been subjected to refrigeration in one form or another. In twenty-three of these cases amputation was eventually performed successfully. These patients as well as the individuals having amputations under anesthesia other than refrigeration were all elderly individuals. They were suffering with either diabetic or arteriosclerotic gangrene of the lower extremities. Such individuals were universally poor surgical risks. Not infrequently the gangrenous extremity was the least of their afflictions. Such individuals are poor ones to use as a base line for comparison of methods of anesthesia. It should be

definitely understood however that refrigeration was not used exclusively for the poorest risks. In both of the series the amputations were either low thigh or mid thigh.

## RESULTS—REFRIGERATION ANESTHESIA

|   |     |        |
|---|-----|--------|
| REFRIGERATION ANESTHESIA                    |     |        |
| Immediate thigh amputation                  | 19  |        |
| Delayed thigh amputation...                 | 4   |        |
| (Preoperative detoxification refrigeration) |     |        |
| Total amputations .....                     | 23  | } → 28 |
| Failures.....                               | 5   |        |
| Deaths.....                                 | 4   |        |
| (17.3%)                                     |     |        |
| NON-REFRIGERATION ANESTHESIA                |     |        |
| Immediate thigh amputation                  | 68  |        |
| Delayed thigh amputation...                 | 2   | } → 2  |
| (Preoperative detoxification refrigeration) |     |        |
| Total amputations .....                     | 70  |        |
| Deaths.....                                 | 13  |        |
| (18.4%)                                     |     |        |
| Principal Anesthetic Agents                 |     |        |
| 1. Cyclopropane.....                        | 60% |        |
| 2. Spinal.....                              | 16% |        |
| 3. Nitrous oxide.....                       | 12% |        |
| 4. Pentothal.....                           | 7%  |        |

Total  
Cases of  
Refrigeration

The above table gives in brief the results obtained. In addition the following observations were recorded: *For refrigeration anesthesia:* (1) Pain and psychic reaction resulted in failure to obtain satisfactory anesthesia in 17 per cent of the cases. (2) Three patients vomited in the postoperative period. (3) Two patients had pneumonia in the postoperative period. (4) two patients were psychotic in the postoperative period. (5) Wound healing was prolonged in practically all cases. In one there was severe infection. In another gas gangrene resulted in death. (6) One patient died of pulmonary embolism. It was thought the application of the tourniquet contributed the trauma causing release of the clot into the general circulation. *For non-refrigeration anesthesia:* (1) Thirteen

of the patients vomited in the postoperative period. (2) Five patients developed pneumonia in the postoperative period. (3) Two patients were psychotic in the postoperative period. (4) Wound healing was satisfactory with but few exceptions. In three superficial infection delayed wound healing. In one gas gangrene resulted in death.

The fact that the mortality rate is practically identical for both series is worthy of particular attention. It was concluded that the application of a tight tourniquet was not a harmless procedure despite refrigeration. Cayford and Pretty believe that the tourniquet should be eliminated as a part of the method.

Especial comment is in order regarding the procedure of detoxification refrigeration. Six patients exhibited toxicity resulting from severely infected, gangrenous extremities. In each case there was a period of delay from a few hours to five days before amputation. During this time the extremity was packed in either ice or ice bags. We were favorably impressed by the improvement in the clinical condition of certain of these individuals. In three a tourniquet was applied on the assumption that it would enhance the refrigeration and prevent absorption of toxins into the general circulation. In two of these patients the period of detoxification refrigeration failed to exert a beneficial effect on their clinical course, and they subsequently died following amputation under refrigeration anesthesia. In the third case a decrease in toxicity was apparent and amputation was accomplished with survival of the patient. In the remaining three cases a tourniquet was not used and clinical improvement occurred in all three. Two subsequently had amputation performed under refrigeration anesthesia and one under general anesthesia. All three of these patients survived. In view of the improvement of the patients in whom the tourniquet was not used it is believed a tourniquet is also unnecessary for this type of case.

The two deaths following the use of the tourniquet emphasized this conviction. The circulation in the gangrenous extremity is poor and refrigeration undoubtedly reduces further the effective circulation. If this is true, the tourniquet can serve no useful purpose.

#### COMMENT

Three hundred years ago the Italian Severino suggested that ice and snow might be used for surgical anesthesia. The re-introduction of this type of anesthesia was made by Allen of New York, in 1941. Variations of temperature reduction have been suggested for numerous conditions both medical and surgical. The name of Temple Fay is well known to everyone familiar with methods for reduction of the general body temperature. Reduced temperatures under dry conditions have been suggested for the treatment of immersion foot, frostbite, traumatic arterial spasm and peripheral embolism. It has been used to allay pain and decrease toxicity in severe burns. It has also been used for cases requiring incision and drainage, as well as minor operations, to the fingers and toes. Small tumors and skin grafts have been removed successfully. In military surgery it has been suggested for use in wounds in view of its successful employment in civilian practice. Mention has been made of the possibility of the application of a tourniquet around the mid-abdomen for refrigeration below the umbilicus. Allen reports that Blakemore, Lord and Stefko were able to amputate dogs' legs, refrigerate them for twenty-four hours, and then replace them surgically with subsequent full recovery of normal function. In all fairness to the latter authors the following is taken verbatim from their article, "after reimplantation of the limbs there is every evidence of a good supply of arterial blood in the reimplanted legs." Nothing is said about a return of the limbs to normal function. Nothing is said about the end result. Furthermore



these authors were primarily interested in blood vessel anastomosis, not refrigeration.

When injury to tissue, collateral circulation, infection and mortality rates are considered it is common to find confusing statements in the literature. Safford states that tissue temperatures below 50°F. may damage tissue when other factors are present. These factors are: (1) certain types of circulatory obstruction, (2) slight pressure and (3) subsequent warming. Safford qualifies his statements by noting that refrigeration will not cause tissue damage unless it is used for over twelve hours. His recommendations are for a temperature higher than that obtained by the use of ice, namely, a skin temperature of 40 to 50°F. and 45 to 65° for deeper tissues. Richards has indicated that tissues distal to the tourniquet are injured. The damage may not be apparent grossly but is apparent on microscopical examination. The symposium on refrigeration by Large, Bruneau and Heinbecker in the November issue of the *Annals of Surgery* give support to Richards' contentions. Recently, Allen has taken these individuals to task for what he believes is an unwarranted condemnation of refrigeration. He states that repeated examinations of amputated limbs has failed to reveal any pathological changes whatsoever. The observations of Blackwood lend weight to the contentions of Richards, Large, Bruneau and Heinbecker. Blackwood states it is known in tissue culture work that a temperature zone between 50 and 80°F. slows anabolic processes while katabolism proceeds and metabolites accumulate. In muscle the accumulation of metabolites means an increase in its lactic acid content and myosin, the main constituent of muscle protein, is unstable on the acid side of neutrality.

From a physiological standpoint the establishment of collateral circulation in the refrigerated extremity does not seem feasible because of the arterial spasm caused by the cold. There are some who

believe that the initial spasm is eventually abolished and that cold preserves the damaged extremity until collateral circulation can be established. Others state a paravertebral sympathetic block is necessary for alleviation of the arterial spasm.

Infection is thought to be held in check and minimized by slowing the metabolism and preventing bacterial growth. It seems equally logical to assume that prolonged cold sets the stage for a really severe infection once the refrigeration is stopped. The experiments of Large and Heinbecker lend credence to the last statement.

The mortality rate for amputations in elderly patients has presumably been markedly reduced if refrigeration was chosen as the method of anesthesia. If a reduction of mortality rate from a percentage of 75 to 25 could be demonstrated and charged off to the efficacy of this method, its justification would be undoubted. Such a reduction, one must remember, might be more apparent than real. A change from poor methods and poor management to improved methods and better management should result in a mortality rate approaching the lower percentage. Refrigeration anesthesia in such a situation might be given the credit when in reality it is only co-incidental with a change for better preoperative and postoperative care. The mortality rate in the series presented here is no better with refrigeration than the group not subject to refrigeration. In both series, however, the mortality rates are considered to be better than average when compared with other similar series of amputations. The usual mortality rate for amputations using refrigeration anesthesia is well over 20 per cent. To date the best that can be claimed for any one group of amputations using refrigeration is 12 per cent. Recently McKittrick performed 132 consecutive major amputations for diabetic gangrene with a mortality rate of only 3.8 per cent. Can the spinal anesthesia he used for this remarkable accomplishment be given all the credit?

This directs attention toward the anesthetic agents, exclusive of refrigeration, used in the amputations herein presented. It was not possible to designate any one of them as the ideal anesthetic for the particular operation in question. This inability to recommend the ideal anesthetic, emphasizes a belief that it is not important what anesthetic is used, as long as the person administering the anesthetic is well qualified. So much the better if this happens to be a physician practicing anesthesia as a specialty. When anesthesia is supervised by such an individual, it can be said without fear of contradiction that the mortality rate for this or any other given procedure will show a decided change for the better.

Regarding the final impression after personal experience and a review of the literature it is sufficient to state that the extent to which refrigeration anesthesia or other variations are acceptable is as yet unsettled. It has been pointed out that every new anesthetic before becoming firmly established must pass through three stages: a period of optimism, a period of pessimism and a period of adjustment. The suggested applications for refrigeration cover a wide field that will be narrowed only by trial and error. Particularly is this true of reduced temperature necessary for actual anesthesia. Allen's admonition in 1941 that undue enthusiasm should be avoided for this spectacular novelty in order to avoid disillusionment remains good advice in 1945.

#### SUMMARY

A series of twenty-three cases of amputation of the lower extremity under refrigeration anesthesia is presented. A second series of seventy cases of amputation with anesthesia other than refrigeration is also presented. The mortality rate for the refrigeration series was 17.3 per cent and for the non-refrigeration series 18.4 per cent.

#### CONCLUSION

Refrigeration anesthesia does not offer advantages over any other type of anesthesia for amputations of the thigh in elderly, poor risk patients.

The use of refrigeration for purposes of detoxification of infected, gangrenous extremities has a limited field of usefulness as a preliminary to amputation.

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# TREATMENT OF INTERTROCHANTERIC FRACTURES OF THE FEMUR\*

## THE USE OF THE HANGING CAST

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THE treatment of intertrochanteric fractures of the femur has been recently well summarized by Stuck.<sup>1</sup> but since the knees and ankles are held immobile for many weeks, there is much residual stiffness and weakness.

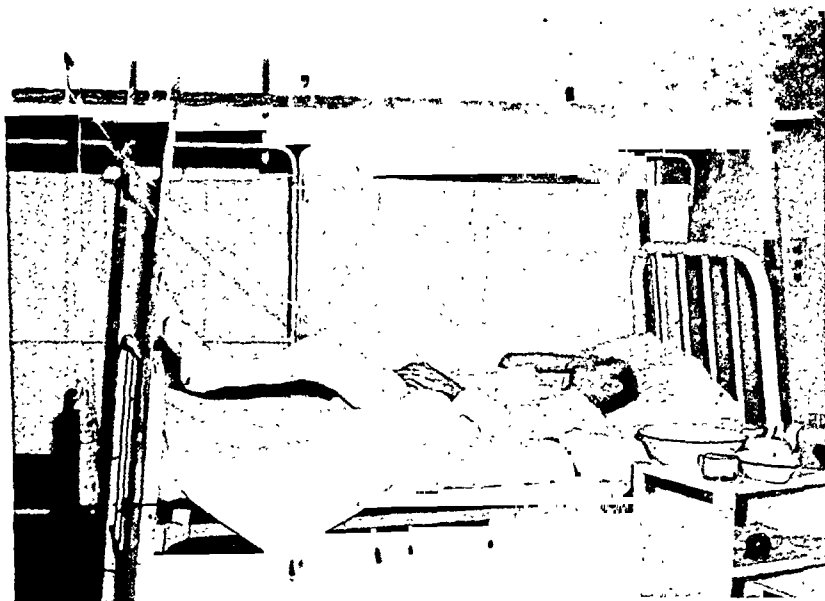


FIG. 1. Patient in bed with traction applied to hanging cast.

He presents the three main methods of treating these fractures and criticizes each as follows:

1. External splints or casts confine the patient to such a degree that a change of position is difficult. This confinement encourages the formation of pressure ulcers, muscular wasting, and residual joint stiffness that may delay general recovery.

2. Traction devices hold the patient in a supine position, and because of this, bedsores and hypostatic pneumonia occur rather frequently. "Well leg" traction does permit patients to be turned or with assistance to be placed in a wheel chair,

3. Internal fixation is usually the method of choice because it allows free motion of the legs and frequent change of position in bed and out. At times, however, intertrochanteric fractures are so badly comminuted and the condition of the patient such that it is impossible to use internal fixation.

A method of treating intertrochanteric fractures by means of a hanging cast was recently described by Johnson.<sup>2</sup> By this method the mortality rate in his series of over fifty cases was decreased from 39.3 to 18 per cent and the duration of hospitalization shortened by twenty-two days.

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The application of the cast is a simple procedure and is done under local anesthesia. After satisfactory sedation a Steinmann



FIG. 2. Cast is permitted to hang when patient is in a wheel chair.

pin is inserted through the lower end of the femur. The purpose of this pin is the prevention of pressure sores and peroneal nerve paralysis, which might occur if enough weight were attached to the cast for reduction of the fracture. Stockinet on the leg and felt padding over the bony prominences is applied up to the mid-thigh region. Then the usual mid-thigh cast is applied, the Steinmann pin being incorporated and the knee placed at 30 to 40 degrees of flexion. The thickness of the cast is varied according to the amount of weight desired, a lighter cast being employed for a smaller person and a fairly heavy cast for a larger person.

Plaster loops are then made from narrow plaster slabs and incorporated in the cast at the knee and the ankle, on the antero-lateral aspect so that when traction is applied to these the external rotation is corrected. When the plaster has adequately

hardened, traction cords may be attached to these loops and from 20 to 35 pounds of weight applied. The pulley is placed at the foot of the bed on the affected side so that abduction is obtained. (Fig. 1.) Traction is employed only when the patient is resting in bed. When the patient is in a chair or on crutches, the weight of the hanging cast gives sufficient traction.

Within several days after the application of the cast, the patient is placed in a wheel chair (two hours twice daily) with the footboard on the affected side turned up, thus allowing the extremity to hang. (Fig. 2.) Some pain is usually encountered when the patient is first put in a wheel chair, but it has been noted that if gentle traction is applied, as advocated by Johnson,<sup>2</sup> the pain is minimized. After one to two weeks, less pain is encountered, and the patient can be up more frequently for longer periods of time. The patient is allowed on crutches after the third week if tolerated. Bearing weight on the affected extremity is not permitted for about three months.

#### RESULTS

The hanging cast has been employed in treating fourteen patients, eleven women and three men, whose ages ranged from forty-eight to ninety-one years. The results are shown in Table 1 on the first eleven patients; the last three patients not being included because sufficient time has not elapsed to evaluate the final results. In almost each instance, the patient treated in this fashion had sustained a severe comminuted intertrochanteric or subtrochanteric fracture that was not suited to treatment by internal fixation.

In several of the cases so treated some stiffness of the knee was encountered after removal of the cast. This apparently resulted from a too prolonged period of immobilization in plaster. However, this residual stiffness responded well to treatment. To prevent or minimize this stiffness it seems wise to remove the cast in

thirty-five to fifty days and to institute physiotherapy. Occasionallly when elastic bandages were

ulcers occurred even though the patients were taken out of bed for two to three hours two times a day. However, because

TABLE I  
SUMMARY OF RESULTS

| Patient | Age | Sex | Type of Fracture  | Days after Injury That Callus Formation Was Noted | Removal of Cast | Results and Complications  |
|---------|-----|-----|---|---|-----------------|--|
| E. S.   | 73  | F   | Extensive comminuted intertrochanteric fracture of the right femur  | ..  | .....           | Cardiac patient; expired 12 days after admission   |
| R. L.   | 83  | F   | Right intertrochanteric fracture  | 10  | 40 days         | Mild bedsore developed even though patient was up twice daily. Healing of fracture and position excellent  |
| A. M.   | 65  | F   | Left intertrochanteric fracture extending down shaft  | 32  | 35 days         | Results good   |
| A. Mc.  | 48  | F   | Extensive left intertrochanteric fracture with slight lateral angulation and upward displacement of the shaft | 17  | 38 days         | Results excellent at the time patient was discharged to a convalescent home                                |
| R. W.   | 76  | F   | Extensive comminuted left intertrochanteric fracture  | 21  | 35 days         | Bedsore developed. Excellent position and healing  |
| H. E.   | 72  | M   | Right subtrochanteric fracture with impaction. Old healed fracture of the right femoral neck                  | 18  | 55 days         | Complete bony union with excellent position in 20 weeks. Patient walked with cane.                         |
| J. M.   | 67  | M   | Old fracture of the neck of the left femur  | ..  | .....           | No evidence of healing in 30 days  |
| M. M.   | 78  | F   | Extensive intertrochanteric fracture of the left femur  | 22  | 42 days         | Left hospital against advice in 25 days; end result when checked later good                                |
| M. B.   | 49  | F   | Right intertrochanteric fracture  | 19  | 51 days         | Because of inadequate traction and abduction, healing was slightly delayed; it was ultimately satisfactory |
| J. K.   | 48  | F   | Intertrochanteric fracture of the right femur   | 20  | 13 weeks        | Excellent results  |
| M. S.   | 87  | F   | Intertrochanteric fracture of right femur   | 16  | 46 days         | Patient up in wheel chair daily. Callus present in 16 days; position excellent                             |

not applied to the affected extremities following the removal of the cast, edema was encountered.

In two of the older cases decubital

early callus formation had occurred, it was possible to remove the cast and thus permit the patient to lie on his abdomen or side. These two patients were seventy-six and

eighty-three-year-old women who had urinary incontinence and definite mental deterioration due to senile changes.

Smith-Petersen nail; the nail later slipped, was removed, and a hanging cast applied two weeks after the injury. When no evi-

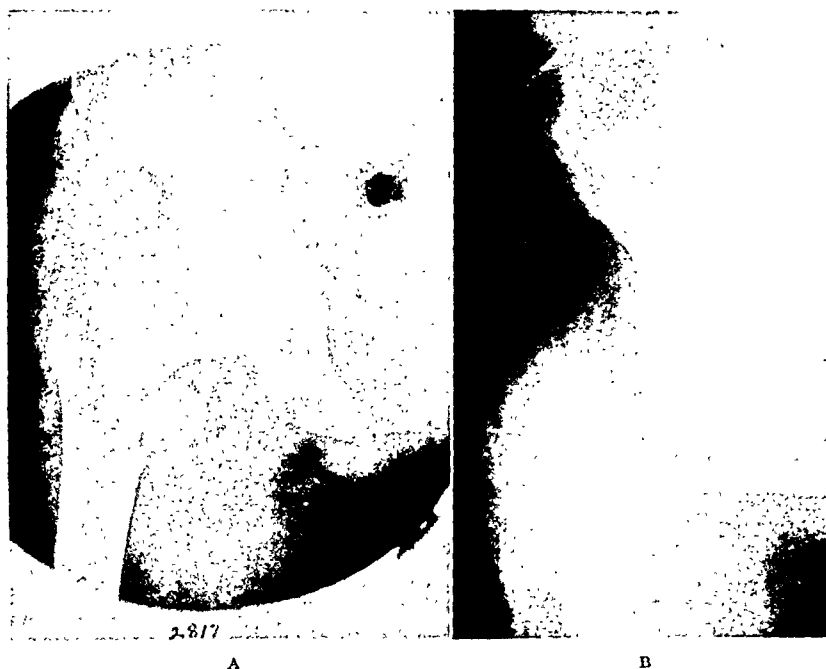


FIG. 3. A, admission x-ray of the right hip of a seventy-three-year old woman who sustained an extensive comminuted intertrochanteric fracture. B, position after five days of treatment. Note the good valgus position already obtained.



FIG. 4. A, admission x-ray of the fractured right hip of an eighty-three year old woman. B, position at ten days. The roentgenologist reported good position and early callus formation.

One patient with a fracture of the femoral neck was first treated with a hanging cast treatment was discontinued.

From the fourteen patients treated we have found that the hanging cast is more effective in the smaller, non-obese patient.

The end result on the fourteen patients studied has been quite satisfactory. While the number of patients is too small to

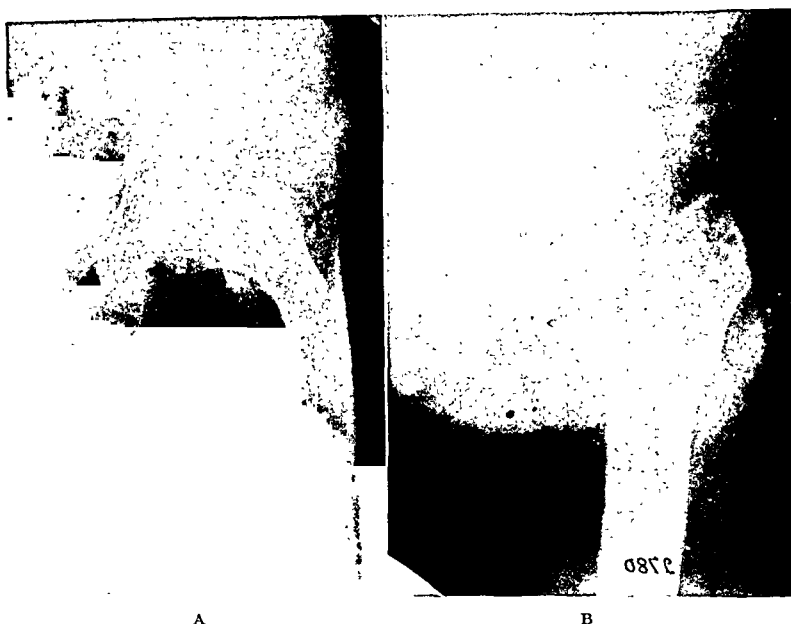


FIG. 5. A, admission x-ray of the left hip of a forty-eight-year old woman who sustained an extensive intertrochanteric fracture with slight lateral angulation and upward displacement of the shaft. B, position at thirty-eight days. Moderate bony union was present. Callus formation was noted as early as seventeen days.

It is believed that callus formation is as rapid as in other forms of treatment and possibly even accelerated. We have also noted a good valgus position in each instance. On several occasions the first x-ray showed a coxa vara position that was easily corrected by increasing the abduction. It is believed that by employing the hanging cast method, adequate position can always be obtained if the physician takes the time and effort to see that the cast is hanging properly (adequate weight, rotation, and abduction). It is usually advisable to check the position by x-ray every few days until good position is obtained.

#### CONCLUSION

From this study we can conclude that although internal fixation is still the method of choice in handling the majority of intertrochanteric fractures, instances will occur (badly comminuted fractures, poor general condition of the patient) in which the hanging cast can be effectively employed.

evaluate the method accurately, a brief summary might be of interest.

Of fourteen patients treated with the hanging case for an intertrochanteric or femoral neck fractures, one patient succumbed (mortality rate 7 per cent). The position of the remaining cases and the motion at the hip joint was good. Some stiffness of the knee and ankle joints occurred although in most instances this was adequately overcome by physiotherapy. In comparison to patients treated by methods other than internal fixation it was believed that the results obtained were quite satisfactory, especially since most of this group of patients were not suitable for nailing, due to an extensive comminuted fracture.

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# NEWER POSTOPERATIVE TRENDS\*

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IN discussing a topic of such broad scope only the more important advances can be given due consideration. There have been a great number of recent new and improved conceptions. It is difficult to discuss postoperative care without mentioning preoperative care, as it is usually a continuation of the latter. At the outset the uncomplicated postoperative course will be considered.

## NUTRITIONAL CONSIDERATIONS

One is so often preoccupied with the primary or specific treatment of the disease that details such as dietary management are entirely forgotten.<sup>1</sup> Regardless of all other factors involved, the patient cannot be expected to have a smooth and uneventful convalescence unless proper nutrition is maintained. Food, water, minerals and vitamins are indispensables.

Food in order to be of value must be ingested, absorbed and metabolized. Often large meals are offered the patient but one seldom takes the trouble to note how little is ingested. Failure to take food may be due to weakness, anorexia, nausea or discomfort. The reason should be ascertained and analyzed. Adequate calories, minerals, vitamins and proteins can be given in the form of a fluid diet.<sup>1</sup> Practically all foods with the exception of milk are transformed into fluids upon reaching the stomach. Solid foods may be tolerated much earlier than usually prescribed and, in fact, will often help relieve distention and cramps. They should be given as early as possible. In other words, food should be taken in the usual manner as early as possible. Fruit juices and milk are not often well tolerated

during the early postoperative course as both have a tendency to be gas forming. Fluids given should be warm or at room temperature. Mild alcoholic beverages are often well tolerated by chronic alcoholic patients. It is good psychology to give small feedings and let the patient ask for more. It makes them think they are really improving.

Water requirement varies a great deal and is dependent on many factors such as the nature and severity of the illness, body temperature, atmospheric temperature, and whether there is vomiting or increased loss of fluids.<sup>1</sup> The required fluid intake of an ill person varies from 3,000 to 7,000 cc. daily.<sup>1</sup> A moderately ill individual not losing a large quantity of fluids may need only 3,000 cc., while another with a high fever, vomiting or losing large quantities of fluids, or one who is dehydrated may require a much larger fluid intake.

The urinary output is a good index as to whether the fluid intake is sufficient. The urinary output should be sufficient to excrete the waste products without depleting the water stores in the body. The daily urinary output should be at least 1,000 cc. and preferably 1,500 cc. The specific gravity for the twenty-four-hour specimen should not exceed 1.020.<sup>1</sup>

Mineral metabolism is of importance in the management of the postoperative patient; however, in this paper the discussion will be confined to sodium chloride. When the salt intake is insufficient, water is not retained in the body because of salt depletion and dehydration ensues.<sup>1</sup> It is fairly well established that a sodium ion

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depletion predisposes to circulatory failure. There is also decreased thirst, appetite and general vigor of the individual.<sup>1</sup> The normally functioning kidneys selectively retain sodium and chloride ions, while the poorly or abnormally functioning kidneys continue to excrete both regardless of salt intake. Salt depletion may result from persistent vomiting, diarrhea or excessive perspiration. The normal salt intake should approximate 5 Gm. but this should be almost doubled in a sick individual because of the increased amount of fluids lost. Salt may be easily given in the diet and fluids ingested. If in doubt as to the salt intake or retention, a blood chloride determination will give the answer.

Vitamins are essential to the maintenance of health and it is obvious that they are likewise essential for smooth convalescence. It should be remembered that certain diseases decrease vitamin absorption and increase their excretion as well as requiring increased amounts for tissue repair. The best preventative against vitamin deficiencies is a generous, well balanced diet.<sup>1</sup> In many postoperatives that is not possible, therefore, vitamins must be furnished by other means. Various forms of vitamins may be given by mouth early in the postoperative course but it should not be forgotten that often the purpose is defeated by destroying or decreasing the already inadequate appetite. Vitamins are probably better given parenterally during the early postoperative course.<sup>1</sup>

The problem of food intake should be further analyzed. It is well known that protein is indispensable and cannot be replaced by other foods. The normal individual requires a protein intake of approximately 1 Gm. per kilogram of body weight per day. In a well person the protein intake can be reduced somewhat if a high caloric diet is administered. When it comes to seriously ill individuals the protein requirement often rises to three or four times the normal, of which very little can be replaced by other foods.<sup>1</sup> Thus, the neces-

sity arises for giving proteins in large enough quantities to prevent protein depletion. If protein depletion takes place, liver damage is sure to follow with resulting depletion of serum proteins, and this in turn produces nutritional edema. Those who are familiar with the Japanese atrocity stories will remember that most of the prisoners of war are reported as being edematous. Their diet is chiefly rice and proteins are nil. Every effort should be made to administer high protein diets in seriously ill patients and in patients who are expected to have a prolonged convalescence. It is suggested by one investigator that the anti-body reaction may be closely associated with protein metabolism.<sup>2</sup> We realize now that solid foods may be tolerated much earlier than ordinarily prescribed. Patients unable to take solid foods will often tolerate milk and eggs in their various forms. If there is a limitation to the amount and variety of food that can be ingested, the choice should be proteins.

Carbohydrates are necessary, but for a short period the body may subsist on an intake of 100 Gm. daily. This amount is probably sufficient to prevent ketosis. The remainder of the calories may be derived from protein breakdown and from fat stores in the body.<sup>1</sup> However, in serious illnesses such a gamble should not be taken, and the intake should approximate 300 Gm. of carbohydrates daily. It is important to remember that vitamin B<sub>1</sub> is necessary for proper carbohydrate metabolism.

The required fat intake is variable depending upon the amounts of proteins and carbohydrates taken. If the above are taken in sufficient quantities, fat can be regarded as almost dispensable. Let it not be forgotten, that fat may be advantageously given under certain circumstances for it is high in calories and may be useful when the amount of intake is limited.<sup>1</sup>

Oral feeding is often impossible or it may be unwise to attempt to maintain

proper nutrition without resorting to other routes. One's ingenuity may be taxed in attempting to maintain the nutritional state in certain postoperative cases such as peritonitis, paralytic ileus, intestinal obstruction and many others. Parenteral feeding, including tube feeding, is gaining a great deal of recognition. Tube feeding should not be resorted to until all other means or attempts at getting the patient to take the necessary food have failed. Patients will often begin eating if told that tube feeding will be discontinued when adequate food is taken by mouth. If gavage be necessary, the feedings should be small, nutritious, warm and injected very slowly. Amigen,\* an hydrolysate of casein, is a good form of protein and is usually well tolerated. This form of food may be given by mouth, by gavage, intramuscularly and intravenously. It should be added that there are other parenteral protein products on the market. Parenteral feedings are substitutes and only substitutes for normal eating.<sup>1</sup> They should be given only when definitely indicated. All surgeons realize that parenteral feedings are absolutely necessary in certain cases and should be begun early and before serious dietary depletions have resulted. This method of feeding should be cautiously prescribed and administered with the greatest of care. The speed of administration depends upon the route used and the substance being given. If administered too rapidly, serious reactions may result and if given too slowly, undue fatigue and exhaustion may result. The fluid intake should be sufficient to replace water lost by breathing, from the skin, vomiting, diarrhea, urine, exudation and transudation.<sup>1</sup> Parenteral fluids administered should contain enough salt to take care of the normal excretion plus any unusual loss, such as by vomiting or excessive perspiration. Isotonic saline may readily be administered subcutaneously and intravenously.

Isotonic (5 per cent) glucose may be given subcutaneously but higher percentages can be given only intravenously. Let it be remembered that 5 per cent glucose in physiological saline cannot be given subcutaneously without untoward reactions because the combination of the two forms a hypertonic solution. Hypertonic glucose should be given slowly in order to prevent unnecessary damage to the vein walls, resulting in thrombosis. Furthermore, some patients complain of an uncomfortable fullness in the abdomen when hypertonic fluids are given rapidly. If large amounts of glucose are given by vein, they should be given in divided doses to maintain continuous utilization and to prevent undue excretion of glucose in the urine. Until recently, the only forms of protein that could be given parenterally were whole blood, plasma and serum. Great strides have been made and are in the process of being made along this line. Now, hydrolyzed proteins and mixtures of amino acids are available for parenteral use. The writer has used them in a number of cases and the results have been satisfactory. If given in sufficient quantities, nitrogen equilibrium may be maintained. Vitamins may likewise be given parenterally for prophylactic and therapeutic purposes.

#### GENERAL PRINCIPLES

Miscellaneous considerations should receive some mention. The abdominal cavity should not be irrigated. On the other hand, all blood and foreign material should be aspirated or removed by sponging. Peritoneal drainage is, as a rule, contraindicated.<sup>3</sup> Dressings should not be too large. They should be snugly applied but not tight, especially is that true of the upper abdomen. Cold applied to postoperative wounds often adds to the comfort of the patient.<sup>4</sup>

The position of the postoperative patient has received considerable comment recently. The trend is toward the Trendelenburg position, but each case should be individualized. Some surgeons believe that

\* Amigen is an enzymic digest of casein and pancreas, containing amino acids and polypeptides. Mead Johnson & Co., Evansville, Ind.

fewer headaches follow spinal anesthesia when the semi-Fowler's position is utilized immediately postoperatively.

Wounds in vitamin c deficiency individuals heal slowly and with poor tensile strength.<sup>5</sup> Cod liver oil ointment applied locally to wounds is thought to stimulate granulation and epithelization.<sup>6,7</sup> It is not at all confirmed that the vitamin content is responsible for the healing qualities. Antiseptic, including alcohol, should not be placed in open wounds as wound healing is definitely prolonged. Normal saline solution is the most satisfactory agent to use for warm moist compresses. However, such applications should not be applied continuously because of maceration of the skin. X-ray therapy is often a valuable adjunct in the treatment of infections. Do not redress clean wounds until time for the sutures to be removed. Sutures should be removed on or about the seventh day and clips a day or two earlier.

Patients should be gotten up as soon as practicable. Following uncomplicated appendectomy, the patient may be allowed up in two to five days. An effort should be made to keep the patient's morale at a high ebb. Visitors should be few and the visits short. Visitors should not come to the hospital to tell their troubles or to be entertained.

The physician should see seriously ill patients at least twice daily. Sedatives should be given cautiously. Joints should not be immobilized longer than definitely indicated. The tendency is toward early motion following tendon repairs. Splinting of infected and injured extremities is an important surgical principle. Most deeply imbedded metallic foreign bodies should be treated conservatively.

The anesthetist should accompany the patient to his bed and should not leave him until a nurse has been detailed to remain until the patient is completely conscious. Often there are instructions which the anesthetist should pass on to the responsible nurse. Too many times a shy, inexperienced, student nurse, a nurse's

aid or an orderly is left in charge of an anesthetized patient. For practical purposes the patient might as well be left alone. It is desirable to have anesthetic recovery rooms in hospitals accommodating surgical patients. The patient should not be kept too warm because metabolism and fluid loss are thus increased. An electric aspirator should be by the bed of any anesthetized patient and should be used for aspiration of mucus or vomitus from the nose, mouth and throat.

Tracheotomy trays should be on all floors where postoperative thyroid patients are assigned. In fact, if complications are anticipated, the tray should remain in the patient's room for two or three days. Thyroidectomy wounds developing hematomas should be explored early. Lugol's solution is being given intravenously in an increasing number of postoperative thyroidectomy cases. Contrary to past opinion, sedatives should be used cautiously in these patients. Mild parathyroid tetany may be controlled by calcium lactate and ammonium chloride by mouth. If this treatment is unsatisfactory, resort to dihydrotachysterol. Stone and associates<sup>8</sup> claim some success with the use of parathyroid gland transplants.

Hand surgery is gaining its deserved place in the field of major surgery. The trend is toward guillotine amputation of extremities with application of skin traction by means of adhesive strips. In this manner less of the extremity is sacrificed. Local heat is contraindicated in most vascular lesions of the extremities.

#### SULFONAMIDES

Something should be said regarding the use of sulfonamides both prophylactically and therapeutically. The use of sulfonamides by mouth, parenterally and especially locally in wounds and in the peritoneal cavity for prophylactic purposes has gained much in popularity. Its value is not to be doubted in the treatment of certain types of lesions<sup>9,10,11</sup> especially war injuries. Sulfonamides are of proven

value in the treatment of many postoperative complications. The trend in civilian practice is away from the use of sulfonamides locally, including intraperitoneal use. Despite its use no surgical "short cuts" should be taken nor any additional daring procedures undertaken.

Well established surgical principles should be observed. In the past, sulfadiazine administered by mouth or parenterally seems to have been more effective than other sulfonamides. At present sulfamerazine is being used in an increasing number of cases. Sulfanilamide is still considered by many to be the best preparation for local use. It is absorbed fairly rapidly and produces little foreign body reaction.

#### BLOOD AND BLOOD SUBSTITUTES

Much has been said recently concerning the use of blood and blood substitutes in surgery.<sup>12</sup> Whole blood and plasma are of undisputed value in postoperative care. The former is of greatest value in blood replacement whether due to blood loss or anemia. Many speak of its tonic effect upon seriously ill patients. To be of greatest value, whole blood should not be more than ten days old when used. Plasma is used in cases of acute blood loss when whole blood is not immediately available. Otherwise, plasma is of great value in: (1) prevention and treatment of shock; (2) in burns, as a prophylactic measure against hemoconcentration, and (3) in protein replacement and in the building of protein stores. Whole blood and plasma are often not given in sufficient quantities to gain the desired result; this is particularly true of plasma. When plasma is really indicated several units are usually needed. Hydrolysates of casein and mixtures of aminoacids are being used to a limited extent.

#### COMPLICATIONS AND TREATMENT

Postoperative complications, their treatment and prevention deserve due consideration. Despite the use of sulfonamides, blood transfusions, improved anesthesia,

improved surgical technic, penicillin and scores of other advances, complications are ever present and must be dealt with as real surgical problems.

One of the most common postoperative complications is atelectasis. Patients with upper respiratory infections should not be subjected to elective surgical procedures. In the majority of cases of atelectasis the amount of lung involved is small and the only proof is the x-ray evidence. The first indication that the patient has atelectasis is a sharp rise in the temperature and pulse rate during the first or second postoperative day. The patient often expectorates a plug of mucus and proceeds to an uneventful recovery without anyone suspecting what has really taken place. In patients with massive pulmonary collapse the temperature rises suddenly to 104° or 105°F. and sometimes much higher. The pulse rate increases correspondingly and the patient becomes cyanotic and dyspneic. These cases require immediate active treatment. In the conservative treatment, steam inhalation and expectorants are thought to be of value. The least that should be done is to support the wound and have the patient cough frequently. The patient's position should be changed frequently. The best position is on the uninvolved side, which is more often the left. As a rule, the patient cannot tolerate this position for any length of time. The treatment of choice is immediate bronchoscopic aspiration and repeatedly in some cases. Tracheal and bronchial aspiration before leaving the operating table, less sedation, frequent change of position, breathing exercises and the use of carbon dioxide inhalations will prevent atelectasis in the majority of cases. Casually written orders are not sufficient. The situation must be adequately explained to the nurse in charge of the patient.

Pneumonia will not be discussed in this paper because it is, without doubt, a product of atelectasis in the majority of instances. In other words, primary postoperative pneumonia is uncommon.

One of the most important problems in surgery is the prevention and treatment of paralytic ileus. Its presence to a variable extent is almost 100 per cent following intra-abdominal and renal operations. The cause is probably reflex. Gentle manipulation of the viscera is a great factor in its prevention. The careful use of retractors should be stressed. This complication should be anticipated in many cases and prophylactic measures instituted. The prophylactic and early use of intestinal suction is an important factor in preventing or minimizing this frequent and troublesome complication. It should be added that gastroduodenal suction is of very little value. No drugs are of proven value. Prostigmine is of questionable value as a prophylactic measure and appears to have no beneficial effect after ileus has manifested itself. The present treatment consists of maintaining fluid and nutritional balance plus instituting intestinal suction. The latter is a life saving measure in many cases and should be instituted early. The tube of preference for intestinal suction is a double tube<sup>13</sup> rather than a double lumen tube. Eight to ten feet of tubing will usually traverse the entire small intestinal tract. The tube should be placed into the duodenum under direct fluoroscopic vision and then advanced at least two or three inches every hour until the lower ileum is reached. It should be added that this procedure is tedious and time consuming but can practically always be accomplished. Recovery is usually rapid and uneventful if proper treatment is used.

Acute gastric dilatation is closely related to ileus and is treated by gastric lavage and by continuous suction if the condition recurs. Often gastric suction is necessary in addition to small bowel decompression. Local heat to the abdomen is of no proven value in stimulating peristaltic activity or in any way decreasing distention.

Peritonitis is a serious complication and requires judicious treatment. Acute bacterial peritonitis should be treated as described above and with a few additional

measures. Sulfonamides should be administered parenterally in large doses. The patient should be well sedated, in fact, almost to the stage of somnolence. It is imperative to maintain proper fluid and nutritional balance. Frequent small whole blood transfusions are indicated. The semi-Fowler's position is the most desirable. If the patient recovers, localization as a rule takes place. The most common site of localization is in the pelvis. Pelvic abscesses in the female should be drained through the posterior vaginal fornix. Drainage in the male should be through the rectum. Other abscesses should likewise be drained extraperitoneally. An exploratory aspiration should not be performed when a subdiaphragmatic abscess is suspected because of the danger of contaminating the pleural cavities and spreading the infection to uninvolved portions of the peritoneal cavity. Simple, early postoperative intestinal obstruction is usually caused by some inflammatory process or plastic adhesions. Practically all of the inflammatory ones and a large percentage of the early adhesive ones will be completely relieved by intestinal suction. Very little time will be lost if the above treatment does not relieve the symptoms. Patients should be followed with frequent x-rays to help determine whether a closed loop exists. If the above treatment does not relieve the symptoms, it should be assumed that a closed loop exists and an exploration should be performed through another incision. It is poor judgment to believe that the risk of a few hours of properly directed conservative treatment is too great. Intestinal decompression by continuous suction, as a rule, simplifies operations for intestinal obstruction. Careful surgery, including peritonealizing raw surfaces, will eliminate many cases of postoperative intestinal obstruction. The above may not be the treatment of choice in intestinal obstruction occurring several weeks postoperatively.

No discussion of postoperative treatment would be complete without some

mention of dicumarol and its clinical evaluation. A great deal has been said and written concerning the use of dicumarol in the prevention and treatment of thrombophlebitis and phlebothrombosis. It is thought that some biochemical or physiochemical change takes place in the blood on or about the sixth postoperative day causing increased blood clotting; however, venous stasis is the most logical etiological factor in the production of the thrombo-embolization. Phlebothrombosis and thrombophlebitis are serious complications and the consequences may be fatal. It is estimated that 1 per cent of major surgical cases develop pulmonary embolism, having its origin in the above mentioned conditions. Embolism is more common following phlebothrombosis than thrombophlebitis because the clot is not as firmly adherent to the vein wall, thus becoming more easily dislodged.<sup>14</sup> Before proceeding to the treatment of the venous complications, something should be said about their prevention. It is a proven fact that such complications are usually due to an improperly managed postoperative course. Until comparatively recently patients upon returning from the operating room were told to remain perfectly quiet in bed and were "snowed under," so to speak, with sedatives for three to seven days. All surgeons realize now that this was ill advised. It is realized that venous stasis and dehydration are important factors in the production of venous complications. It should be stated that thrombosis probably precedes any change in the vein wall.<sup>15</sup> After the thrombus forms secondary inflammatory changes occur. We must take active steps toward the elimination of the known etiological factors. Deep breathing and leg exercises are of indisputed value. However, this complication still occurs in some postoperative patients despite the usual preventative measures. Here dicumarol has come to our rescue. The writer's<sup>16</sup> experience has not been so wide, but from his observations and from the wide acclaim in the literature,

it should be prescribed when trouble is to be expected. It is not without dangers and, therefore, should not be used indiscriminately. It is indicated in patients who have had extensive pelvic operations, operations in which there was probable trauma to large veins, cesarean sections, patients who have had previous venous or allied complications and following any other surgical procedure which might predispose to such complications.<sup>17</sup> The drug should be started on the third postoperative day using an initial oral dose of 200 mg. followed by 100 mg. the next day, but no more dicumarol should be given until after forty-eight hours, at which time an additional 100 mg. daily may be administered until the prothrombin time reaches 60 per cent of normal. The desired prothrombin time is 60 to 30 per cent of normal. It must be emphasized that daily prothrombin determination must be performed and the drug given accordingly. Prothrombin time should remain elevated until the patient becomes ambulatory and then it should be allowed to return gradually to normal.

Therapeutically dicumarol should be given in the same manner, observing the above mentioned precautions. When an unexplained fever develops during the postoperative course thrombophlebitis or phlebothrombosis should be suspected and a diligent search made for its detection. Treatment should be instituted immediately upon making the diagnosis. The course of the complication may be greatly shortened and the patient be made more comfortable. Dicumarol is, of course, to be used only as an adjunct to other therapeutic measures known to be of value. The only serious untoward reaction reported from its use is a bleeding tendency, which is chiefly into the operative wound. This is not common and does not present a major problem. The bleeding tendency which develops in a small percentage of cases can be effectively combatted by fresh whole blood transfusions and accord-

ing to some recent writers, by the use of large doses of vitamin K.<sup>18,19</sup>

Wound disruption is a serious but uncommon complication of the postoperative course. Prophylactic measures are of utmost importance. Dietary deficiencies should be corrected to the greatest possible extent preoperatively. Special attention should be given to the replacement of proteins and vitamin C. Vitamin A is also thought to be a factor in the proper healing and tensile strength of wounds. Often it is not possible to postpone operations until the various deficiencies have been corrected, and in such cases special postoperative measures are indicated. Nitrogen balance may be properly maintained and vitamin deficiencies corrected by parenteral feedings. Other important factors which may be responsible for the production of eviscerations are: (1) hematomas in the wound; (2) wound infection; (3) sensitivity to catgut;<sup>20</sup> (4) use of continuous suturing; (5) abdominal distention; (6) persistent coughing or vomiting, and (7) improper approximation of tissues.

When wound disruption occurs it is truly a surgical emergency. The patient should be immediately taken to the operating room and a secondary closure performed. In many cases it can be satisfactorily accomplished under local anesthesia. The closure of choice is accomplished by the use of interrupted through-and-through non-absorbable sutures. The sutures should be placed close together.

Urinary tract complications are too commonly seen. In all probability most of these could be prevented by the proper use of the catheter. According to some recent investigations in the Navy, a great deal of urinary retention is psychic in origin and may be prevented by conscientious and properly trained hospital personnel.<sup>21</sup> Any postoperative patient who does not void every six hours or who voids only small quantities frequently should be catheterized. Overdistention of the bladder further depresses its ability to empty and opens the way for infection.<sup>22</sup> After infec-

tion is present it may be rather difficult to control, despite the most judicious treatment. Sulfonamides and other urinary antiseptics are of value.

#### SUMMARY AND CONCLUSIONS

An attempt has been made to correlate and summarize the newer postoperative advances into a readable thesis. The writer is not presenting these newer trends as original ideas, for a large percentage of them have appeared elsewhere.

Great emphasis has been placed upon the importance of nutrition and fluid balance in the smooth convalescence of postoperative patients. The treatment must be individualized to meet the presenting needs. The body metabolism should be disturbed as little as possible. Protein intake should receive precedence.

Emphasis should be placed upon the free use of blood and blood substitutes. Too often the amounts given are inadequate.

Unfortunately, since the advent of sulfonamides, blood plasma and many other additions to our armamentarium, the tendency is to forget many minor details which in a great part would prevent many of the common postoperative complications. Proper management of the postoperative course is at least as important as surgical technic. The frequent and early use of intestinal suction will go a long way toward shortening the convalescent period in many cases and is actually a life saving procedure in some.

Dicumarol, while still in the experimental stage, appears to have a promising future in the prevention and treatment of thrombo-embolization. It is presented as an adjunct to other therapeutic and preventative measures.

The author is greatly indebted to Drs. A. N. Collins, M. G. Gillespie and W. G. Strobel, Duluth, Minnesota, for assistance in the preparation of this paper.

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# BICIPITAL TENDOVAGINITIS

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**B**ICIPITAL tendovaginitis is a frequent cause of disability in the "painful shoulder syndrome."

Tendovaginitis of the long head of the biceps muscle may be serous or fibrinous and it is usually considered to be the result of trauma, infection or a combination of both.

The long head of the biceps arises from the supraglenoid tubercle situated immediately above the glenoid rim, is continuous with the glenoid labrum, and tranverses the joint. Although it is intracapsular, it remains extrasynovial, as it receives a tubular sheath from the synovial membrane, which invests the tendon for a varying distance after it has left the capsule. This synovial sheath and the tendon are retained in the intertubercular sulcus (bicipital groove) by the transverse humeral ligament, a thickened part of the capsule which bridges the groove and is attached to both tubercles, and also by a fibrous prolongation from the tendon of the pectoralis major.

Schrager has pointed out that the vulnerability of the long head of the biceps muscle to both specific and non-specific infection is based on a number of factors. (1) *Anatomical*: The relative instability of the shoulder joint and constant movement of the tendon as it arches over the head of the humerus subjects it to injury and dislocation. (2) *Physiological*: The tendon is taxed beyond its physiological requirements by the many strenuous activities of the shoulder joint, and (3) *because of its vestigial nature*, constant friction and overuse, it falls prey to infection.

There is both statistical and experimental evidence to support the view that rapidly repeated muscular movements over a long period of time, particularly if the

muscles involved are unaccustomed to such work, commonly causes tendovaginitis. In experimental animals, rapid, passive movements, continued over a period of several hours, caused fraying of the surface of the tendons and tendon sheaths, as well as edema and interstitial hemorrhage of the surrounding soft tissue. Acute tendovaginitis may be serous or fibrinous, the latter being called peritendinitis crepitans. In both types of acute tendovaginitis there is edema particularly in the areolar tissue of the outer part of the sheath and hyperemia with sparse infiltration by mononuclear cells. In acute fibrinous tendovaginitis or peritendinitis crepitans there are collections of fibrin throughout the inflamed sheath; but according to Howard not within it. Howard is of the opinion that fatigue rather than mechanical destruction of tissue is responsible for the lesion and supports his view with the observation that the involved tissue shows a diminution in glycogen, a rise in hydrogen ion in concentration, and the presence of lactic acid. Repeated attacks may lead to a chronic stenosing tendovaginitis.

The condition is most frequently seen in young male adults engaged in strenuous activities. The history is that of gradually increasing pain and stiffness of the shoulder joint. The pain may be generalized over the shoulder, often radiating up into the neck to the scapular region, anteriorly to the subcoracoid area, or down the arm to the forearm. The patient may complain of inability to carry out certain movements, especially abduction of the arm; of lifting heavy objects or other activities that tend to put the tendon on stretch; of pain at night which awakens him and forces him to find a more comfortable position. Pain on motion of the affected tendon is the

presenting symptom, while tenderness on pressure over the sheath of the tendon of the long head of the biceps is the most characteristic physical finding.

The condition must be differentiated from other lesions resulting from minor trauma. Muscular strain, ligamentous sprains, and acute traumatic synovitis are usually preceded by a single traumatic episode and are accompanied by pain and tenderness limited to the structure involved. Fractures of the greater tuberosity with little displacement, subacromial bursitis with calcification, arthritis of the acromioclavicular joint are common and must be ruled out by roentgenographic examination. Other conditions such as scalenus anticus syndrome, and subacromial bursitis without calcification must be excluded by special examinations and often by infiltration with novocain into the painful area. The latter we have found to be a very valuable diagnostic aid.

#### TREATMENT

This condition responds readily to infiltration therapy with 1 per cent novocain and normal saline. This type of treatment is simple, inexpensive, readily available, and may be used as an office procedure.

The long head of the biceps tendon may be marked on the surface by a line beginning at the acromial process and just lateral to the coracoid process extending downward approximately three inches and about one-half inch lateral to the medial edge of the deltoid muscle. When pressure is made over this area, if the condition of a bicipital tendovaginitis is present, it causes the patient to wince with pain. Having marked the location of the tendon, the skin on this line is infiltrated with 1 per cent novocain in three places by making three wheals at the upper, middle, and lower end. The infiltration is carried down to the cortex of the bone. The point of the needle is then withdrawn 2 or 3 mm. and about 10 cc. of novocain are injected in and about the tendon and tendon sheath.

This is followed by the injection of about 15 cc. of normal saline. This procedure is repeated through each wheal on the line marking the position of the tendon. Often during the procedure the patient will complain of severe pain. This is probably caused by the distention of the tendon sheath with the novocain or saline. The treatment, if applied correctly, gives immediate relief, only to be followed by an increase in symptoms for the first twenty-four to forty-eight hours. The patient is encouraged to get under the shower and limber up the shoulder with gentle exercises for the first few days. Usually after four days there is complete relief of pain. Occasionally it is necessary to repeat the procedure if symptoms persist.

In the past thirteen months on an orthopedic service of a station hospital, fourteen cases of bicipital tendovaginitis were seen. The average age of the patient was thirty years. Only five gave a history of trauma. The duration of symptoms varied from twenty-four hours to eight years. The one case of eight years' duration was of the chronic stenosing type. The right shoulder was involved thirteen times, the left once. There were no bilateral cases in the group. Two patients of the group required more than one treatment. One had three and obtained about 50 per cent relief, the other had two and had no relief. This was the chronic stenosing case and it was realized from the start that the chances of success were poor; nevertheless, treatment was given to see what effect it would have. Of the patients treated 85.7 per cent responded favorably. If the one case of chronic stenosing type is not included the percentage is increased to 92.8 per cent. The average time of disappearance of symptoms was four days. No recurrences were observed; however, it is only fair to state that the average time of observation was somewhat less than three months. One case was observed nine months. Due to the movements of troops it was almost impossible to get an accurate follow up.

## COMMENT

The mechanism which precipitates the acute symptoms as well as the general etiology remains entirely obscure. Infection and trauma are mentioned most frequently as possibilities. The fact that thirteen out of fourteen cases occurred in the right shoulder leads us to believe that the additional trauma of use in right-handed individuals might be an important factor.

## CONCLUSION

1. Bicipital tendovaginitis in young male adults engaged in strenuous activities is a relatively common condition and deserves more consideration in the differential diagnosis in the clinical entity that has become designated as the "painful shoulder syndrome."

2. Trauma and infection are mentioned as possible etiological factors.

3. The right shoulder is most commonly affected in right-handed individuals suggesting that the additional trauma of use may be a factor in the etiology.

4. The average age in our group of cases was thirty years.

5. Infiltration therapy has given ex-

cellent results in our series of cases presented.

6. Treatment is accompanied by relief of pain and restoration of a full range of motion at the shoulder joint.

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# Case Reports

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## ACUTE SUPPURATIVE APPENDICITIS WITH ABSCESS FORMATION AND SUBSEQUENT PERFORATION OF THE ANTERIOR ABDOMINAL WALL

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ACUTE suppurative appendicitis with rupture, abscess formation, and subsequent perforation of the abdominal wall was mentioned in textbooks on surgery written in the latter part of the nineteenth and the beginning of the twentieth centuries.<sup>1,2</sup> Many present day authors do not mention the possibility of perforation through the abdominal wall as a complication of appendiceal abscess.<sup>3,4,5</sup> The volume of literature pertaining to the appendix is so vast that it does not lie within the modest limits of this article to make a comprehensive review in order to state exactly the number of instances in which cases have been reported or the incidence of invasion of the anterior abdominal wall by appendiceal abscesses. A few cases have been reported in the last twenty years, and a discussion of phlegmons of the abdominal wall as a complication of acute appendicitis was presented by Argentine surgeons in 1940.<sup>6</sup> Cullen described a "progressively enlarging ulcer of the abdominal wall involving skin and fat, following drainage of an abdominal abscess apparently of appendiceal origin."<sup>7</sup>

The case here reported is the only one on record at Mount Carmel Mercy Hospital, Detroit, Michigan, where some 12,000 cases of appendicitis have been cared for in the past six years.

Abscess formation occurring with appendicitis is one of the most common and will probably remain one of the most

common complications.<sup>8,9,10</sup> The prime purpose in presenting this case is not to record a rarity, but to emphasize the fact that such a condition may be encountered, even in present day general acceptance of early operation for appendicitis, and to point out that such complication of appendicitis should be included in the differential diagnosis of masses in the anterior abdominal wall.

### CASE REPORT

A forty-six year old, white male entered the hospital complaining of a mass in the right lower quadrant.

Two weeks prior to admission, the patient developed an acute pain in the right costo-vertebral angle. One day later the pain moved anteriorly and downward, localizing just above and midway along Poupart's ligament. When the pain in the back was first experienced, the patient was nauseated, but did not vomit. The pain became less intense and the patient thought that it would be gone shortly. This expectation was not justified, but the patient still procrastinated.

He had been constipated since the onset of the pain. Three days prior to admission a mass appeared in the right inguinal region.

Physical examination revealed an acutely ill, well developed, well nourished, adult male whose mental attitude was markedly cloudy. Heart and lungs were negative. Examination of the abdomen revealed an obvious mass in the right lower quadrant, limits of which reached the midline up to the umbilicus and extended down the entire length of Poupart's ligament. (Fig. 1.) The mass was highly in-



FIG. 1. The skin marking above the fluctuating area is due to a hot water bottle burn before admittance to the hospital.



flamed. One area about two inches across and beginning one inch above and midway of Poupart's ligament showed necrosis of the epidermis. The center of this area was fluctuant. The liver and spleen were not palpable. Rectal examination revealed a packed content of hard feces. The extremities were normal. The temperature was 103°F., pulse 90 per minute and the blood pressure was 120 systolic and 70 diastolic.

Urine examination was normal. The blood showed 13,000 white blood cells, 69 per cent hemoglobin and a normal serology.

The patient was taken to the operating room, where a small stab wound was made over the area of fluctuation. Approximately eight ounces of bloody, purulent material with a colonic odor was obtained. Culture of the material revealed *Escherichia coli*. Exploration of the wound disclosed continuity with the abdominal cavity. A drain was inserted. The wound was irrigated twice daily with tyrothricin and inflammation and swelling receded rapidly. On the second postoperative day the patient's right lower extremity was noticeably enlarged and painful. Measurements were taken and the right thigh was found to be three and three-fourths inches larger than the left at the mid-thigh level. The external veins showed no signs of thrombosis or phlebitis. Ten days postoperatively the abscess had almost completely receded and the extremities were normal.

The patient was discharged from the hospital on the fourteenth postoperative day and was instructed to return in two weeks.

Upon readmission, the stab wound was found to be practically healed. The blood, urine and temperature were normal. Another operation was performed and the appendix was removed. It was found adherent to the anterior abdominal wall adjacent to the internal inguinal ring. The appendix measured 3 cm. in length and showed signs of distal necrosis. The pathological report was acute suppurative appendicitis. The patient made an uneventful recovery.

#### COMMENT

To be factually certain of the diagnosis, based on the finding of a mass in the right inguinal region, is rather difficult at times, Psoas abscess, lymphadenitis, hernia, granuloma inguinale, tumors, and other conditions must be considered. In the case reported, the pain began in the right

costovertebral angle. This would suggest a psoas or perinephritic abscess. In all probability the pain in this region was due to encroachment upon the ilio-inguinal or iliohypogastric nerve. None of the classical symptoms of acute appendicitis were present except nausea. The enlargement of the limb, subsiding rather promptly and without untoward incident, reminds one that thrombophlebitis is another possible complication of a ruptured appendix with abscess formation.

Lewis and Firor<sup>11</sup> suggest that most appendiceal abscesses begin between the cecum and the anterior abdominal wall. This being the case, penetration of the abdominal wall could be a natural sequence. Another explanation of the chain of events in this case could be that the internal ring was dilated and the appendix might have been strangulated. This was suspected and at the time of operation an attempt was made to demonstrate this condition, but due to the dense adhesions in the region, which were not disturbed in the presence of infection, investigation was unsatisfactory. At the second operation, however, the appendix was found adjacent to the inguinal ring and it was released therefrom. Cases have been reported of appendicitis occurring in inguinal hernias. Waldman<sup>12</sup> reported three cases in which the appendix was found in the hernial sac. Winn<sup>13</sup> reported similar cases. A third possible factor could be the peritoneal reaction to the inflamed appendix. Such reaction might succeed in completely walling off the appendix from the abdominal cavity proper, making invasion of the adjacent abdominal wall the easier route for extension and rupture.

It may be of interest to note that Breslin,<sup>14</sup> in discussing gas bacillus infection of the abdominal wall in appendicitis, reported a case in which extension occurred to the left abdominal wall. In his case he considers the fact of rather unusual interest that the infection of the right rectus muscle was limited in the extension upward by one of the tendinous inscriptions and further



points out that the infection spread from the right rectus across the barrier of the linea alba to involve the left rectus muscle and the left abdominal wall, probably, he says, by way of the pyramidalis muscle. Thus it may be well to add the point in differential diagnosis concerning the anterior abdominal wall that there are cases of left-sided appendicitis and also the possibility of extension from a right-sided appendiceal abscess to invasion of the abdominal wall on the opposite side. The better supplied the surgeon is with the knowledge of instances of the unusual and the improbable, the better prepared he may be to find the correct solution when presented with the unexpected and the bizarre.

#### SUMMARY

A case of acute suppurative appendicitis with abscess formation and subsequent perforation of the anterior abdominal wall is presented.

Concerning a mass in the abdominal wall, particularly one in the right lower quadrant, differential diagnosis should include extension of an appendiceal abscess.

Cases similar to the one here reported have occurred but are comparatively rare at the present time.

The probable manner in which the abdominal wall was invaded is discussed.

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## POLYPS OF THE APPENDIX

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**P**OLYPS of the gastrointestinal tract have received considerable attention in the surgical literature of recent years. However, polyps are rarely observed in the vermiform appendix. Only twenty-one cases have been reported.

Collins,<sup>1</sup> in 1932, collected seventeen cases and contributed the report of a similarly affected male patient aged seventy-six years. In 1942, Sanes and Patchin<sup>2</sup> called attention to two additional cases and reported one of their own.

The infrequency with which appendiceal polyps are encountered is attributed in part to the failure of pathologists to inspect carefully the lumina of appendix specimens.

Between January, 1941, and November, 1944, there were 898 appendices examined in this hospital. The subsequent case report illustrates the single instance in which a polyp was found and, in consequence, denotes an unparalleled incidence of 0.11 per cent.

*Etiology.* Records indicate that the sexes share the lesion equally. However, young adults, those in whom appendicitis is most frequent, are more often affected. In nineteen reports in which the age was given, fifteen patients were below and four above the age of forty years; the eldest was eighty years old.

The pathogenesis of polyps is unknown, but speculation suggests two possibilities: a familial polypoid hypertrophy of the mucosa and a reactive hyperplasia following prolonged inflammation. In those cases occurring early in life, sometimes beginning in childhood, there is a distinct tendency for polyps to occur in several descendants of the same lineage. The familial hypothesis seems to gain support also through the circumstance that appendiceal polyps are frequently associated with similar tissue changes elsewhere in the gastrointestinal

tract, at sites involved in various members of successive generations. A negative family history, however, is not necessarily significant because relatives of the patient may, for the time being, be asymptomatic or their polyps, as is often the case, may be difficult to demonstrate.

*Symptoms.* Usually there are no symptoms directly attributable to an appendiceal polyp. Therefore, the diagnosis is difficult, or equivocal, before operation. Complaints are most often the result of associated disease, although they may occasionally arise from a morbid state initiated by the polyp. Analysis of fifteen cases revealed that acute appendicitis with perforation and subacute appendicitis each occurred once, chronic recurrent appendicitis occurred nine times and intussusception of the ileum and appendix occurred four times. Melena is an occasional complication. The patient referred to in the current case report had acute suppurative appendicitis and the polyp was considered an incidental finding, but there were signs and symptoms previously which, because of their subsequent improvement, were attributed to the polyp.

*Pathology.* Grossly, polyps of the appendix resemble those seen in other anatomic locations. They may be single or multiple. (In the case of Sanes and Patchin<sup>2</sup> there were two oppositely directed and overlapping polyps.) Ordinarily they are soft, pedunculated, or sessile tumors of the mucosa and submucosa in which the essential neoplastic element, composed of glandular epithelium, encompasses a supporting structure of fibrous tissue and its vascular components. They differ from fibromas, hemangiomas, and lipomas in that the latter are surrounded by normal mucosa. Some polyps are so large as to fill completely the appendiceal

lumen, much like a cast, and produce varying degrees of obstruction. More commonly, however, they measure from 0.5

cancerous change. True malignancy, however, has not been reported, although Sanes and Patchin<sup>2</sup> cite a case in which associated polyps of the colon were carcinomatous.

#### CASE REPORT

A white male army medical corps officer, aged thirty-three years, was admitted to the hospital, June 11, 1944, complaining of abdominal pain which had been present thirty-six hours.

The family history was irrelevant rather than negative in that the father suffered from diabetes mellitus. Although the patient's previous general health had been considered good, he had three to five well formed, normally appearing stools daily for as long as he could remember.

Abdominal colic was first experienced in 1933. It was accompanied by an urgency to defecate and was soon relieved by the evacuation of a large, black, loose, tarry stool. The following day bowel movements were normal in number, character, and consistency. One month later, the abdominal cramps recurred and persisted for the succeeding two or three consecutive weeks. During this interval large quantities of bright red blood were mixed with, or surrounded, the eight to ten daily evacuations. Occasionally mucus was observed in the stools. Proctosigmoidoscopic findings led to the diagnosis of ulcerative colitis. Parasites were not recovered. Relief was temporarily afforded by local treatments which were continued for approximately four months.

Between attacks, which recurred irregularly every six months, the stools, numbering three daily, were occasionally streaked with bright red or dark blood. Often the urge to defecate ended in the expulsion of large quantities of flatus only. Coarse foods, especially those with a high cellulose content, were avoided because they seemed to exaggerate the condition. While in the Pacific theater of operations, October, 1943, the symptoms became so severe as to necessitate hospitalization. Sigmoidoscopic examinations revealed numerous small ulcers of the sigmoid colon which, in two weeks, increased in size and depth. There was also a generalized, local hyperemia of the intestinal mucosa. Parasites were not recovered from the ulcers nor from the feces. These findings were

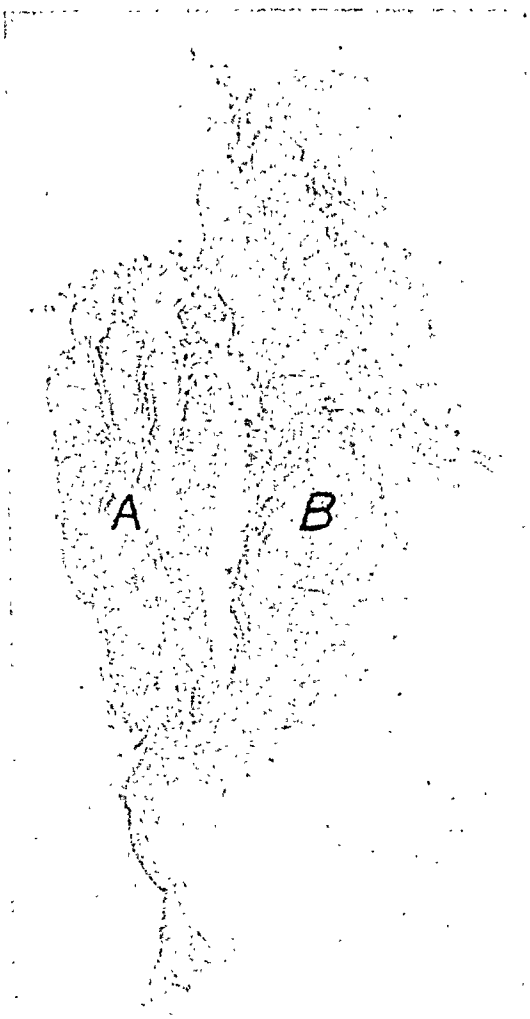


FIG. 1. Longitudinal section of polyp: A, polyp; B, wall of appendix.

to 3.7 cm. in length and the majority are intermediate to these measurements.

Microscopically, appendiceal polyps are adenomatous in character. In some the submucosa is covered with apparently normal epithelium but there is usually a preponderance of mucus-secreting goblet cells or the tubules are enlarged as compared with the normal. In one case<sup>2</sup> there were venous thrombi and minute fecal concretions. Often there is metaplasia, epithelial proliferation, nuclear hyperchromatism and mitosis, signs of a pre-

essentially verified at an army general hospital in the United States in January, 1944.

Interval studies were made at this hospital

The abdomen was generally tender, especially in the right lower quadrant; rebound tenderness was marked and the psoas sign was

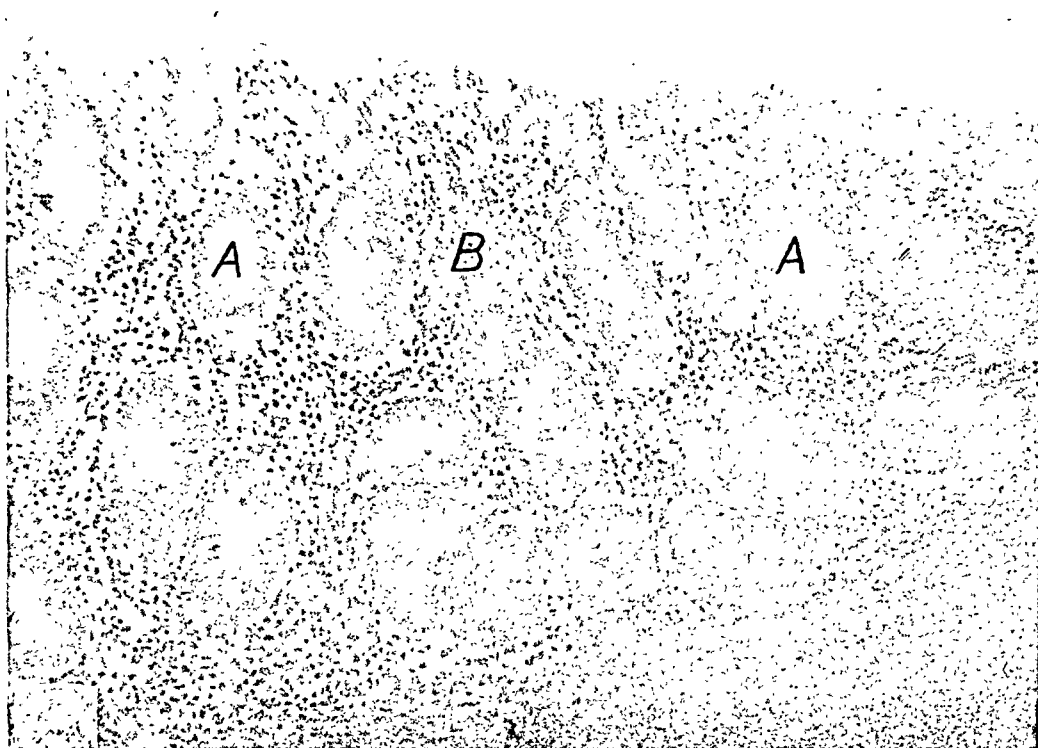


FIG. 2. Mucous surface of polyp: A, mucous glands; B, inflammatory infiltration. ( $\times 200$ .)

on May 10, 1944. There was slight abdominal tenderness more evident in the right lower quadrant, particularly at McBurney's point, and, to a lesser degree, along the course of the descending and sigmoid colon. The blood count, urinary findings and Kahn reaction were normal. X-ray study after an opaque enema revealed complete filling of the large bowel and terminal ileum. The appendix was not visualized. There was increased segmentation, attributed to irritability, of the lower descending and sigmoid colon. The postevacuation film showed approximately 10 per cent of the contrast medium remaining in the large bowel. Except for a slight hyperemia, the proctosigmoidoscopic findings, for a distance of 25 cm., were negative.

On June 9, 1944, thirty-six hours prior to his most recent hospitalization, the patient was awakened by generalized, colicky abdominal pain. About four hours later nausea and vomiting occurred. By the following noon the pain had localized rather diffusely in the right lower abdominal quadrant. The pain then became more acute and constant; it did not radiate and it was exaggerated by walking.

The urine and blood pictures were normal. Repeated blood counts revealed between 7,000 and 8,000 leukocytes with an average of 70 per cent neutrophils. The blood pressure was 140/90, the temperature 100°F. and the pulse rate 104 per minute.

A diagnosis of acute appendicitis was made and operation, through a right rectus incision, was performed immediately. The small intestine and colon were normal in appearance. There was free, straw-colored fluid in the peritoneal cavity. The appendix was red, edematous and partially covered with a fibrinous exudate; its lumen contained pus.

Pathological examination showed the appendix to be 8.5 cm. in length and 12 mm. in its maximum diameter. There was a fusiform swelling in the midportion covered by a plastic, fibrinous exudate. No perforation was found. The serosa of the distal portion was mottled with petechial hemorrhages. On cross section, the wall appeared slightly thickened and quite hemorrhagic. At the proximal end of the appendix there was a finger-like, fleshy process, 9 by 2 mm. in size, attached to the mucosa and projecting distally into the lumen. It was soft

in consistency and had the gross appearance of a polyp. It partially obstructed the appendiceal channel.

Microscopic examination of sections made from the proximal end of the appendix showed the wall to be somewhat thickened, with heavy deposits of fat in the submucous tissue. Large numbers of polymorphonuclear leukocytes were seen throughout all tissue layers. Areas of hemorrhage were present in the mucosa which was markedly ulcerated and extensively replaced by necrotic inflammatory exudate. The polypoid mass observed grossly consisted of a fibrous stalk arising from the submucosa and covered by glandular epithelium. The fibrous stroma was densely infiltrated with lymphocytes and polymorphonuclear leukocytes. The epithelium of the surface was intact and showed many small, oval and elongated glands. The mucosal stroma contained many eosinophilic and neutrophilic polymorphonuclear leukocytes, as well as plasma cells. The distal end of the appendix wall was eccentrically thickened with a diffuse infiltration of polymorphonuclear and red blood cells. The mucosa was ulcerated except for a few small remnants. Diagnosis: Polyp of the appendix with secondary obstruction and acute ulcerative and purulent appendicitis.

Recovery from the operation followed a normal course. The patient was discharged from the hospital on the fourteenth postoperative day and returned to active military duty two weeks later.

Upon re-examination, October 19, 1944, the officer was in excellent physical condition. His weight had increased to its normal standard. There was no recurrence of cramps, diarrhea, or melena. The stools, which numbered three daily, were normal in form, color, and consistency. Coarse foods were eaten sparingly, but in greater quantity and variety than formerly. They did not induce discomfort as in the past. X-ray examination by a double contrast method failed to reveal a lesion in the colon. The evidence of colitis in the descending and sigmoid colon, shown by examination on May 10, 1944, had disappeared. Proctosigmoidoscopic examination, November 3, 1944, in which the sigmoidoscope was passed 25 cm. and the mucosa visualized for an additional 6 cm., revealed nothing abnormal.

#### COMMENT

A higher incidence of appendiceal polyps would be revealed if all removed appendices were more carefully examined. To the twenty-one cases previously reported in the literature another rather typical example is added.

Polyps, except for melena, are usually asymptomatic and, therefore, difficult of diagnosis. X-ray or proctosigmoidoscopic evidence of polyps elsewhere in the gastrointestinal tract may suggest a similar lesion in the appendix, but single and isolated polyps do not produce clearly defined filling defects. It is the practice of roentgenologists, therefore, to use double contrast media. A negative family history is of no importance; and one that is positive affords but vague testimony upon which to base confidence.

In retrospect, the polyp under particular consideration figuratively cried out for recognition. Its site, although indefinitely localized, might have been suspected. The recurrent, colicky, abdominal pain marked the small bowel or the appendix as its source. The tenderness in the right lower quadrant, more acute at McBurney's point, during paroxysms and in the course of free intervals should have focused attention principally upon the appendix. Non-visualization of the latter viscus by x-ray examination, although an inconstant diagnostic factor, was significant because the appendiceal lumen was occluded by the polyp. Recurrent, unexplained melena should have suggested the possibility, if not the probability, of a polypoid lesion somewhere in the intestinal tract. Nevertheless, were it not for the superimposed acute suppurative process, the diagnosis would not have been made.

A more fortunate aspect is that the associated conditions or complications require surgical exploration and almost universally point to the appendix as the offending organ. An obstructing or inflamed polyp conceivably might simulate, or actually initiate an attack of acute ap-

pendicitis. Whether such circumstance prevailed in the above case is conjectural, but the polyp and the appendix showed identical degrees of inflammation and the lumen was obstructed.

It is interesting to speculate concerning the pre-existing diarrhea and ulcerative colitis, both of which were relieved after the appendix was removed. Did the polyp disturb the appendix sufficiently to make of it a trigger mechanism through which the colon was stimulated into spastic contractions intermittently? And was the diarrhea sufficiently irritating to produce inflammation and ulceration which, in turn, resulted in a vicious cycle? The

appendix has been known to induce irritability of the colon; and prolonged non-parasitic diarrhea has been considered a cause of inflammation and ulceration of the rectosigmoid. The relief of symptoms, the demonstrable colonic improvement and the general well being of the patient since operation warrant the conclusion that there was a polyp-appendix-colon syndrome in the case proximately reported.

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CYSTS or abscesses connected with the bladder are found in the hypogastrium, originating from the urachus. Urine discharges from the umbilicus if the urachus is fully open. Those posterior to the bladder may arise from the prostate or seminal vesicles. Dermoid or hydatid cysts may rarely involve the bladder wall, encroach upon the retrovesical pouch and should be excised.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# BENIGN TUMORS OF THE DUODENUM\*

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**N**EOPLASMS of the small intestine make up a small but important percentage of gastrointestinal tumors.

Eighteen out of fifty-five or 26.4 per cent of all tumors were located in the duodenum. Of the benign tumors, fourteen out of thirty-three or 42.4 per cent were in the duodenum and of the malignant tumors, four out of twenty-five or 16 per cent were at this site. These data are tabulated in Table 1.

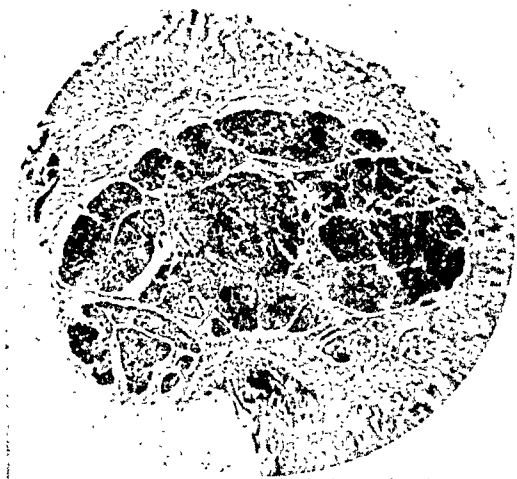


FIG. 1. Case III. Microphotograph showing pancreatic rest in duodenum; hematoxylin and eosin  $\times 50$ .

It is difficult to understand how this major portion of the digestive tube, lying between the stomach and the large intestine and rectum, sites of predilection for neoplasia, should be so spared. It is our intent in this communication to consider mainly benign lesions that occur in the duodenum.

In reviewing 64,300 surgical specimens removed at operation from 1929 to 1945 and 4,480 autopsies performed from 1922 to 1945, we found fifty-eight tumors in the small intestine of which thirty-three or 56.9 per cent were benign, and twenty-five or 43.1 per cent were malignant. Of the benign tumors, fourteen were located in the duodenum, eight in the jejunum, and eleven in the ileum; of the malignant tumors, four were in the duodenum, six in the jejunum and eleven in the ileum. In four cases, the location of the tumor was not specified.

TABLE 1

| Lesion       | Duodenum |          | Jejunum | Ileum | Small Intestine | Total |          |
|--------------|----------|----------|---------|-------|-----------------|-------|----------|
|              | No.      | Per Cent |         |       |                 | No.   | Per Cent |
| Benign...    | 14       | 42.4     | 8       | 11    | ..              | 33    | 56.9     |
| Malignant... | 4        | 16.0     | 6       | 11    | 4               | 25    | 43.1     |
| Total..      | 18       | 26.4     | 14      | 22    | 4               | 58    | 100      |

## CASE REPORTS

**CASE I.** J. S., a sixty-six year old white male was admitted to the Jewish Hospital of Brooklyn, February 18, 1927, dyspneic and acutely ill with the past history of right upper quadrant pain and jaundice on several occasions. He died soon after admission.

At necropsy, there was chronic cholecystitis, cholelithiasis with a calculus impacted in the common bile duct, and acute hepatitis. As an incidental finding, in the duodenal wall adjacent to the ampulla of Vater there was a firm nodule measuring 2 mm. in diameter. This nodule protruded from beneath the mucosa and on cut surface was grey white.

Diagnosis: Fibroma in duodenum.

**CASE II.** M. S., a fifty-five year old white female, underwent resection of a portion of the transverse colon for annular carcinoma ten years prior to admission. She entered the hospital on May 14, 1934, complaining of lower abdominal pain. At operation stenosis of the

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colon was found and ileosigmoidostomy was performed using a Murphy button. She died two days postoperatively.

were well demarcated and the lobules were separated by loose, somewhat edematous connective tissue septa.

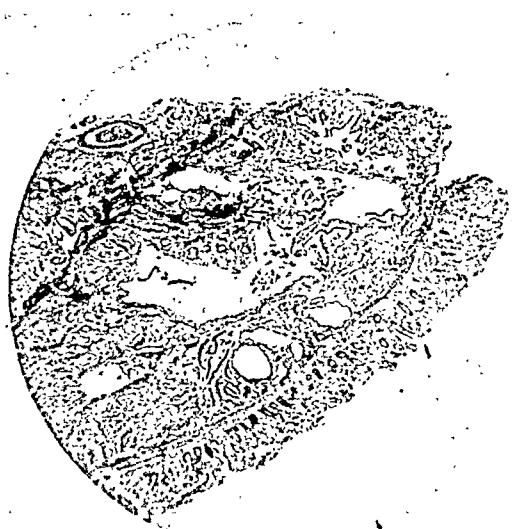


FIG. 2. Case iv. Microphotograph showing gastric rest in duodenum; hematoxylin and eosin  $\times 50$ .

At necropsy, generalized peritonitis and a cauliflower carcinoma of the sigmoid were found. Projecting from the duodenal mucosa, there was a small firm polyp which on cut section was finely lobulated.

**Microscopic:** The mucosa appeared intact. Within the submucosa and muscular coats, there were islands of pancreatic acini and ducts widely separated by bands of smooth muscle and dense fibrous connective tissue.

**Diagnosis:** Aberrant pancreatic tissue in duodenum.

**CASE III.** S. G., a twenty-three year old white male, was admitted to the Jewish Hospital of Brooklyn with a twenty-four hour history of headache and backache, fever, drowsiness, and vomiting. There was neck rigidity and a positive Kernig sign. Meningococci were cultured from the spinal fluid. He died soon after admission.

At necropsy, there was a purulent meningitis and focal pneumonia. In the second portion of the duodenum, there was a firm nodule measuring 5 mm. in diameter. This projected from beneath the mucosa and on cut section was lobulated.

**Microscopic:** Preparation from the nodule showed normal mucosa at one end. In the deeper portions of the muscular coat there were islands of pancreatic tissue. The acini and ducts

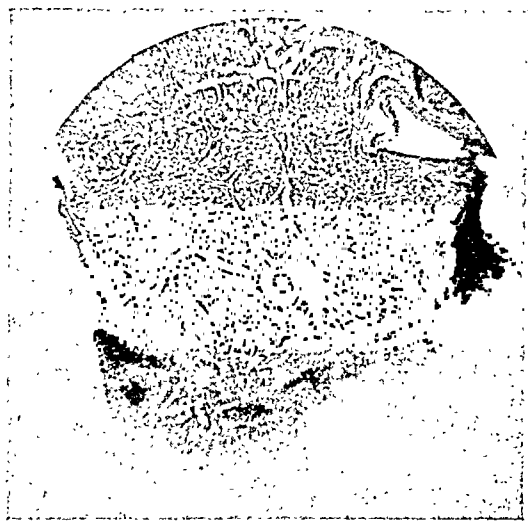


FIG. 3. Case vi. Microphotograph showing papillary adenoma in duodenum; hematoxylin and eosin  $\times 50$ .

**Diagnosis:** Aberrant pancreatic tissue in duodenum.

**CASE IV.** H. K., a seventy-nine year old white male, was admitted to the Jewish Hospital of Brooklyn with a three-day history of generalized abdominal pain. X-rays one year prior to admission showed pyloric stenosis. On admission, the patient was in shock, his abdomen was rigid, and he died one day after admission.

At necropsy, there was a perforated duodenal ulcer with generalized peritonitis, bronchitis and focal pneumonia. Three cm. distal to the papilla of Vater there was a flat, well circumscribed nodule measuring 1.3 by 1.0 cm. It was pale yellow and freely movable beneath the mucosa. On cut section, the surfaces were smooth and grey pink.

**Microscopic:** Normal duodenal mucosa was noted at one end. Beneath the lamina propria there was a well defined muscularis mucosae. Immediately subjacent to this there were numerous branching tubular structures lined by tall columnar cells whose cytoplasm was abundant and stained pale. The nuclei were vesicular and were basally placed. These resembled gastric glands and they extended into the muscular coats.

**Diagnosis:** Aberrant gastric tissue in duodenum.

**CASE V.** R. M., a seventeen year old white



female, was admitted to the Jewish Hospital of Brooklyn on January 10, 1939, in an unconscious and moribund state. For twenty-four

hours prior to admission there had been swelling and ecchymosis about the left eye with exophthalmos. She died soon after admission.

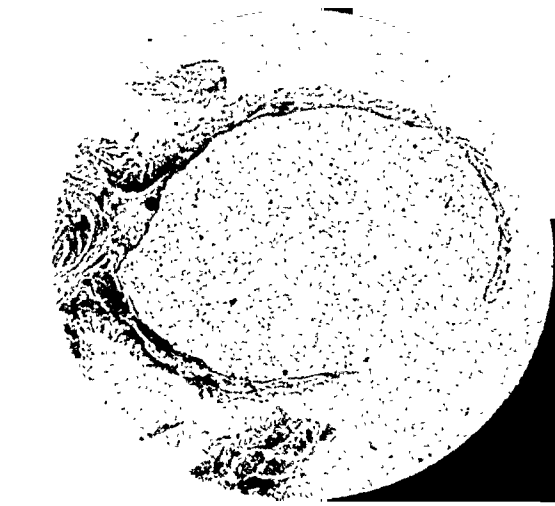


FIG. 4. Case x. Microphotograph showing lipoma of duodenum. Note attenuated mucosa and groups of Brunner's glands; hematoxylin and eosin  $\times 10$ .

At necropsy, there was a cellulitis of the left orbit with exophthalmos, acute glomerulonephritis, and acute meningo-encephalitis. As an incidental finding there was a nodule projecting from beneath the mucosa of the duodenum. This measured 0.8 cm. in greatest diameter and was freely movable within the wall.

Microscopic: The duodenal mucosa was well preserved and beneath the muscularis mucosae Brunner's glands were seen. Beneath this there were islands of well formed pancreatic acini and ducts. These were separated into lobules by bands of fibrous connective tissue.

Diagnosis: Aberrant pancreatic tissue in duodenum.

CASE VI. N. F., a seventy-two year old white male, entered the hospital with the complaints of generalized bone pain, back pain, and constipation of five weeks' duration. Physical examination was negative except for a fractured left clavicle and two fractured ribs. He died seventeen days after admission with the clinical impression of multiple myeloma.

At necropsy, there was a hypernephroma of the left kidney with metastases to the skeleton,



FIG. 5. Case xii. Microphotograph showing papillary adenoma of duodenum; hematoxylin and eosin  $\times 10$ .

liver, right adrenal gland, esophagus and heart. Projecting from the duodenal mucosa 1.5 cm. distal to the pylorus, there was a well circum-

scribed nodule measuring 4 mm. in diameter. The cut surface was yellow pink.

Microscopic: Only at one end was normal duodenal mucosa seen. Elsewhere, it was completely denuded and replaced by necrotic tissue. In the muscular coat there were numerous vascular stalks upon which tall columnar cells were mounted in one or more rows. Similar cells were also seen lining irregular lumina which contained various amounts of pale staining material. The nuclei were vesicular and round or oval. The stroma was everywhere scanty.

Diagnosis: Papillary adenoma in duodenum.

CASE VII. H. L., a fourteen month old white male infant, was admitted to the hospital on March 10, 1940, because of physical and mental retardation. He died one month after admission during an attack of tonsillitis.

At necropsy, left subdural hemorrhage, atelectasis and emphysema, and focal pneumonia were found. Projecting from the mucosa of the duodenum there was a firm freely movable polyp measuring 1.2 cm. in diameter.

Diagnosis: Adenomatous polyp in duodenum.

CASE VIII. E. B., an eighty-eight year old white male, a cardiac of several years' duration, was admitted to the hospital on April 3, 1941, in congestive failure. He did not respond to therapy and died on the fourth hospital day.

At necropsy, there was bilateral focal pneumonia, generalized arteriosclerosis with particular involvement of the coronary arteries,

and weight loss. A firm rectal mass was palpated. The patient died after a three week hospital stay.



FIG. 6. Case XIII. Microphotograph showing lymphangioma in duodenum; hematoxylin and eosin  $\times 10$ .



FIG. 7. Case XIII. Same as Figure 6. Note the loose arrangement of endothelial lined channels; hematoxylin and eosin  $\times 50$ .

and with coronary occlusion and myofibrosis cordis.

In the duodenum, 12 cm. distal to the pylorus, there was a firm flat lobulated mass measuring 2.0 by 2.0 by 0.3 cm. This was attached to the mucosa by a wide pedicle and was freely movable. On cut section, the surfaces were grey pink.

Diagnosis: Adenomatous polyp in duodenum.

CASE IX. J. W., a sixty-nine year old white male was admitted to the Jewish Hospital of Brooklyn on April 11, 1942, a year after he was found to have chronic myelogenous leukemia. He died on the day of admission.

At necropsy, there was leukemic myelosis involving the bone marrow, spleen, adrenal glands, left testis, and lymph nodes. Within the wall of the duodenum there was an elevated, firm, yellow brown nodule measuring 1.1 cm. in diameter. This projected from beneath the mucosa into the lumen, and on cut section was yellow brown.

Microscopic: The nodule consisted of pancreatic tissue undergoing autolytic changes.

Diagnosis: Aberrant pancreatic tissue in duodenum.

CASE X. A. P., a sixty-seven year old white female, was admitted to the hospital on September 8, 1942, with a six-month history of intermittent diarrhea, tarry and bloody stools,

At necropsy, there was adenocarcinoma in the rectum with metastases to the lungs, and cirrhosis of the liver with esophageal varices and splenomegaly. Extending into the lumen of the duodenum there was a spherical yellow mass. This was soft and attached by a narrow pedicle. It measured 1.2 cm. in diameter and on cut section was homogeneous yellow.

Microscopic: The mucosa was not unusual and Brunner's glands were seen in the submucosa. Within the submucosa there was a large circumscribed area composed of adipose tissue cells. This was surrounded by a band of dense connective tissue and was of polypoid configuration.

Diagnosis: Lipoma in duodenum.

CASE XI. R. B., a forty year old white male, had a heart murmur from the age of fifteen. He developed subacute bacterial endocarditis in the latter part of 1941 and was admitted to the hospital in August, 1942. He died three months after admission.

At necropsy, there was thrombo-ulcerative endocarditis of the mitral valve and healed endocarditis of the mitral, aortic and tricuspid valves. There were focal pneumonia, infarcts in the spleen and kidneys, and focal embolic glomerulonephritis. In the duodenum, adjacent to the pylorus, there was a firm, raised,

grey white nodule. This measured 2.1 by 2.0 by 0.5 cm. and was finely lobulated.

Microscopic: There were islands of pancreatic acini and ducts within the muscular coat of the duodenum.

Diagnosis: Aberrant pancreatic tissue in duodenum.

CASE XII. R. W., a two and one-half month old white male infant, was admitted to the hospital on July 1, 1944, because of cough and weight loss. While at the hospital he developed anorexia, bronchopneumonia, and had fatty stools. He died six weeks after admission.

At necropsy, there was cystic fibrosis of the pancreas, bronchitis, focal pneumonia, and atelectasis and emphysema. In the duodenum, surmounted upon mucosal folds, there were two polyps. These measured 4 and 2 mm. in diameter and were pink in color and attached to the posterior wall 4 and 5 cm. distal to the pyloric ring.

Microscopic: The polyps were broad based and covered by normal duodenal mucosa and submucosa bearing Brunner's glands. The pedicles and stroma were composed of dense fibrous connective tissue and contained irregular sized and shaped gland-like lumina lined by tall columnar cells with basal nuclei and foamy granular cytoplasm.

Diagnosis: Adenomatous polyps in duodenum.

CASE XIII. H. N., a seventy-two year old white male with chronic pulmonary disease of many years standing, was admitted to the hospital on August 18, 1944, with the chief complaint of dyspnea. A right pneumothorax was present which was relieved by decompression. He died suddenly on the sixth hospital day.

At necropsy, there was bilateral healed pulmonary tuberculosis, bilateral bronchiectasis, and focal pneumonia. Attached to the duodenal mucosa by a broad base 2 cm. distal to the papilla of Vater, there was a pink yellow polyp measuring 2.1 by 1.0 cm.

Microscopic: The mucosa and submucosa were not unusual. At one site they were out-pocketed in polypoid fashion. There were numerous Brunner's glands throughout the submucosa, both in normal duodenum and in the polyp. The polyp consisted of a loose, irregular network of delicate empty vascular spaces of various sizes lined by flat endothelium.

Diagnosis: Lymphangioma in duodenum.

CASE XIV. A. H., a fifty-four year old white female, underwent cholecystostomy and then cholecystectomy at another hospital for cholecystitis and cholelithiasis. She was admitted to the hospital on January 19, 1945, for jaundice. At operation stricture of the common duct at the ampullary region was found. Several centimeters removed from the papilla of Vater, within the wall of the duodenum, there was a yellow gray nodule measuring 1.5 cm. in diameter. This was removed with a portion of duodenal wall.

Microscopic: The nodule consisted of pancreatic acini and ducts.

Diagnosis: Aberrant pancreatic tissue in duodenum.

#### COMMENTS

The occurrence of benign tumors in the small intestine was once thought to be exceedingly rare. Up to 1917, there were 118 cases reported in the literature. King<sup>1</sup> reviewed these and added one of his own, making the total 119. Raiford,<sup>2</sup> in his exhaustive study of 11,500 autopsies and 45,000 surgical specimens at the Johns Hopkins Hospital, found only eighty-eight neoplasms of all types in the small intestine. Morrison<sup>3</sup> reviewed 2,434 autopsies and 10,705 biopsies at the Queens Hospital, Belfast, and was able to collect only twenty-one primary tumors of the small intestine. Rankin and Newell<sup>4</sup> reported thirty-five benign tumors of the small intestine from the Mayo Clinic.

Ewing<sup>5</sup> states that 3 per cent of all intestinal malignancies occur in the small intestine. In Raiford's series the small intestinal tumors constituted 8.9 per cent of all the gastrointestinal tumors. Of all the benign growths 23.8 per cent were in the small intestine and of all the malignant growths only 4.9 per cent.

In King's series of benign tumors of the small intestine, five out of 119 or 4.7 per cent were in the duodenum. In Raiford's study, thirteen out of fifty or 26 per cent were in the duodenum. In Rankin and Newell's series, fourteen out of thirty-five or 40 per cent were duodenal. Morrison found only thirteen benign tumors in the

small intestine of which one or 7.7 per cent was in the duodenum. He did not, however, include in his series heterotopic nodules, which the others did. Of these there were three, which would bring his percentage up to 25 per cent. A summary of these and our findings is tabulated in Table II.

TABLE II

|                          | Tumors of Small Intestine |        |          |           |          |  | Tumors in Duodenum |          |           |          |
|--------------------------|---------------------------|--------|----------|-----------|----------|--|--------------------|----------|-----------|----------|
|                          | Total                     | Benign |          | Malignant |          |  | Benign             |          | Malignant |          |
|                          |                           | No.    | Per Cent | No.       | Per Cent |  | No.                | Per Cent | No.       | Per Cent |
| Hoffman and Grayzel..... | 58                        | 33     | 56.9     | 28        | 43.1     |  | 14                 | 42.4     | 4         | 16.0     |
| Raiford.....             | 88                        | 50     | 57.8     | 35        | 42.2     |  | 13                 | 26.0     | 8         | 21.1     |
| Morrison.....            | 21                        | 13     | 61.9     | 9         | 38.1     |  | 1                  | 7.7      | 1         | 11.1     |
| King.....                | ..                        | 119    | 100      | ..        | ..       |  | 5                  | 4.7      |           |          |
| Rankin and Newell.....   | ..                        | 35     | 100      | ..        | ..       |  | 14                 | 40.0     |           |          |

The commoner types of benign duodenal growths according to Bockus<sup>6</sup> are the adenoma, the myoma, the lipoma, and the fibroma. Golden<sup>7</sup> collected seventeen cases from the literature and added two of his own. These included twelve adenomas (five of Brunner's glands), three myomas, a hemangioma, a fibroadenoma, a calcified fibromyoma, and a lymphangio-endothelioma. Balfour and Henderson<sup>8</sup> reported three adenomas, two myomas, and a hemangioma. Among Raiford's cases were four adenomas, three lipomas, two nodules of heterotopic pancreatic tissue, a cystic

tumor, an argentaffinoma, a hemangioma, and a fibroma. Rankin and Newell presented five adenomas (two of Brunner's glands), six myomas, two hemangiomas, and a cystadenoma. Neurogenic tumors occur in the duodenum as cited by Ransom and Kay<sup>9</sup> and King. The adenoma is the commonest benign tumor found. It may be of two types, the mucosal gland or the characteristic Brunner gland type. Jacobius,<sup>10</sup> in 1940, reviewed seventeen cases of Brunner's gland adenomas occurring in the duodenum reported in the literature and added one of his own, making the total eighteen.

In our series, there were four adenomas, six pancreatic rests, a fibroma, a lipoma, a gastric rest, and a lymphangioma. The various types of tumors found by us and others are tabulated in Table III.

Many duodenal tumors are asymptomatic and are discovered only incidentally at autopsy. Some may, however, cause symptoms and require surgical treatment. The common and presenting complaint is melena; in these cases a polypoid tumor with an ulcerated surface is usually found. Occasionally, the ulcer syndrome may be mimicked. Kellogg<sup>11</sup> reports a case of intussusception due to a Brunner gland adenoma in the duodenum. Such occurrences are infrequent because of the comparative fixation of the duodenum to the posterior abdominal wall. Obstructive symptoms may occur if the neoplasm is large enough to impinge upon the lumen.

TABLE III

|                            | Total | Adenoma | Myoma | Pancreatic Rest | Brunner Gland Adenoma | Hemangioma | Lipoma | Fibroma | Cystic Tumor | Lymph Angioma | Fibroadenoma | Argentaffinoma | Gastric Rest | Fibromyoma |
|----------------------------|-------|---------|-------|-----------------|-----------------------|------------|--------|---------|--------------|---------------|--------------|----------------|--------------|------------|
| Hoffman and Grayzel.....   | 14    | 4       | ..... | 6               | .....                 | .....      | 1      | 1       | .....        | 1             | .....        | .....          | 1            | .....      |
| Golden.....                | 19    | 7       | 3     | .....           | 5                     | 1          | .....  | .....   | .....        | 1             | 1            | .....          | .....        | 1          |
| Rankin and Newell.....     | 14    | 3       | 6     | .....           | 2                     | 2          | .....  | .....   | 1            | .....         | .....        | .....          | .....        | .....      |
| Raiford.....               | 13    | 4       | ..... | 2               | .....                 | 1          | 3      | 1       | 1            | .....         | .....        | 1              | .....        | .....      |
| Balfour and Henderson..... | 6     | 3       | 2     | .....           | .....                 | 1          | .....  | .....   | .....        | .....         | .....        | .....          | .....        | .....      |
| Total.....                 | 66    | 21      | 11    | 8               | 7                     | 5          | 4      | 2       | 2            | 2             | 1            | 1              | 1            | 1          |
| Percentage.....            | 100%  | 31.8%   | 16.7% | 12.1%           | 10.6%                 | 7.8%       | 6.6%   | 3.0%    | 3.0%         | 3.0%          | 1.5%         | 1.5%           | 1.5%         | 1.5%       |

The diagnosis of duodenal lesions, at best, is difficult. They should be considered in upper gastrointestinal hemorrhage in the absence of gastric tumor or peptic ulcer. High gastrointestinal obstruction, often sudden in onset, may be due to such a tumor. Often, the patient may complain only of vague upper abdominal distress.

Little is found on physical examination. The epigastrium may be tender or a mass may be palpated in this general region. If obstruction is present, the usual signs of obstruction are present.

There is one aid invaluable in reaching a diagnosis. By roentgen ray examination, it is possible to demonstrate, in a great percentage of cases, a duodenal filling defect. It is even possible, at times, to outline polypoid tumors. X-ray study is the only accurate method for diagnosis other than direct visualization.

#### SUMMARY

A review is presented of tumors of the small intestine together with a presentation of fourteen cases of benign tumors of the duodenum.

The tumors of various series are presented in tabular form.

A discussion of their occurrence, frequency, and symptomatology is likewise presented.

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# MIXED BACTERIAL GANGRENE OF AN EXTREMITY TREATED WITH PENICILLIN AND SULFADIAZINE

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MIXED bacterial or streptococcic gangrene is a type of gangrene which is limited to the skin and subcutaneous tissues. It may be one of the most alarming and serious infections of an extremity encountered in medical practice. This condition may be considered of infrequent occurrence judging by the paucity of case reports. A survey of the literature fails to disclose any cases in which patients were treated with the sulfone derivatives or penicillin. Because of the apparent infrequency of its occurrence, it may not be recognized by one who is not thoroughly familiar with its manifestations. Due to this circumstance, coupled with the fact that so far the sulfonamides and penicillin have not been applied in combating this virulent infection, we feel justified in recording our experience with one patient treated with these drugs.

## REVIEW

We are indebted to Meleney<sup>1</sup> for differentiating streptococcic gangrene from other types of gangrene. His observations were published in 1924. Since 1924, a total of thirty-nine authentic cases affecting the extremities has been collected from the literature. (Table 1.) This condition may occur in other regions of the body, such as the abdomen,<sup>2,3</sup> breast,<sup>4</sup> penis and scrotum,<sup>5</sup> vagina<sup>6</sup> and chest wall.<sup>7</sup> However, the infection, when it involves regions other than the extremities, is usually less fulminating in its course.

An analysis of the cases reported (Table 1) reveals that the disease may affect any age group. The youngest patient is eighteen months of age, the oldest sixty-one years. The male sex predominates over the female

in the ratio of  $5\frac{1}{2}:1$ . With the exception of nine cases, a focus of infection or portal of entry for the organisms was encountered in all instances, the most frequent being an abrasion, small pustule or a furuncle.

The initial finding is usually swelling, which may remain localized or may extend with alarming rapidity beyond the point of entry. An entire extremity may be involved within twenty-four hours from the onset. Pain is not marked. In gangrene due entirely or predominantly to the hemolytic streptococcus, the part involved becomes reddened. Usually on the second to the fourth days irregular patches of dusky purplish discoloration appear on this reddened surface. The reddish discoloration invariably precedes the dusky mottling and extends beyond the borders of the dusky discoloration. Vesicles and bullae may develop. The dusky areas then coalesce and frank gangrene occurs. On the eighth to the tenth day separation of the gangrenous areas takes place. Lymphadenopathy occurs rarely. Necrosis of the whole or part of the extremity may supervene. In untreated, and less frequently in treated cases, the necrosis advances and abscesses appear in distant portions of the body. The subcutaneous tissue or the lungs are the most frequent sites. Death ensued in 18 per cent of the collected cases.

The systemic reaction is usually not marked. In the collected cases (Table 1) the temperature on admission to the hospital varied from normal to  $104^{\circ}\text{F}$ . The majority of the patients had a fever ranging from  $99$  to  $101^{\circ}\text{F}$ . The symptoms usually associated with infection, such as malaise and prostration, are encountered. These patients do not appear as ill as one

would expect from the severity of local involvement.

A survey of the reported cases (Table 1) revealed an average white cell count of 17,000 on admission to the hospital. The count varied from 6,050 to 28,600. The polymorphonuclear percentage averaged 82, ranging from 68 to 96.

The streptococcus was found in every instance. In the majority of cases this organism was hemolytic in type. Other organisms, however, have occasionally been isolated, such as *Staphylococcus albus*, hemolytic and non-hemolytic staphylococcus aureus, Gram-positive diplococcus, *Bacillus pyocyaneus* and an unidentified Gram-positive or negative bacillus. A pure culture of hemolytic streptococcus was found in seventeen instances.

In nineteen cases blood cultures were made. No organisms were found in eleven of the cases; in the remainder hemolytic streptococci were recovered.

#### CASE REPORT

The patient, a white male, age eighteen and one-half months, was in good health until 7 P.M. on October 8, 1944. One week prior to this date he sustained a small sandburr wound on the thenar eminence of the right hand. This area became infected, and on October 7th the patient's aunt opened the wound with a needle. At 5 P.M. on October 8th the child was found crying outside his home. Shortly thereafter the mother noted swelling of the third and fourth fingers of the right hand. By 7 P.M. all the fingers and the entire hand were edematous. He was taken to a local medical doctor who applied splints to the forearm and wrist in the belief that the child had sustained an injury. When the child was put to bed at 9 P.M. the swelling had extended as far as the elbow. No redness or discoloration of any type was observed at this time. The child slept well throughout the night. By 10 A.M. on October 9th the entire right arm, shoulder region and right side of the chest were swollen. Patches of dusky discoloration on the dorsum of the hand and the forearm were first noted at noon on the same date.

Physical examination at 3 P.M. on October

9th in the office revealed a well nourished child who did not appear especially ill. He was quite alert and displayed no fear or anxiety. The temperature was 99.4°F. by rectum.

On the mid region of the thenar eminence a small wound about the size of a pinhead was found. No pus could be expressed from this wound.

The entire right upper extremity was swollen at least to twice the normal size. The skin of the fingers and hand was stretched very tight. The edema extended over the right chest anteriorly and downward as far as the costal margin.

Areas of deep bluish discoloration were present over the entire right arm, shoulder region and right side of the chest. These areas of discoloration were irregular in outline and size. Some of these areas measured as much as 5 to 7.5 cm. in diameter. It should be emphasized that no erythema was noted on the involved extremity or on the chest. There was no local increase in temperature. The radial pulse was palpable. The entire affected area was exquisitely tender to touch and the patient resented most emphatically any attempt at movement of the right arm. Crepitation of tissue was not detectable.

A general examination failed to reveal any noteworthy findings. The white count showed 10,800 cells with 54 per cent polymorphonuclear leukocytes and 44 per cent lymphocytes. A roentgenogram of the right arm did not evince the presence of gas in the soft tissues.

The patient was admitted to Mercy Hospital at 5:30 P.M. on October 9th. Ten thousand units of penicillin were administered intramuscularly immediately upon admission. At 7 P.M. 15 gr. of sodium sulfadiazine were given subcutaneously. The penicillin was repeated at 8:45 P.M.

At 9:15 P.M. the purplish discoloration of the arm had increased in intensity and extent. The swelling of the right side of the chest wall had progressed as far as the midline and the purplish areas had increased in size. No blebs, bullae, erythema or crepitation of tissue were noted. When not disturbed, the patient displayed no evidence of pain or even discomfort. His temperature had not exceeded the admission level of 99.4°F. by rectum. The pulse was of good quality and not unduly accelerated. He took liquids readily.

| Author                 | Age | Sex | Portal of Entry  | Duration of Illness before Hospitalization | Admission Temperature | Admission White Count | Per Cent Polymorphonuclear Cells | Part Involved | Organism from Wound   | Blood Culture                 | Treatment  | Result on Discharge   |
|------------------------|-----|-----|------------------|--|-----------------------|-----------------------|----------------------------------|---------------|---|-------------------------------|--|---|
| McLeneay, F. L. (1924) | 30  | M   | Boil             | 4 days                                     | 100.7                 | 6,400                 | ..                               | Foot          | Hem. strep. Staph. aur. Gram + B. Hem. strep.               | Pos. hem. strep. 8th day Neg. | Incisions Hot soaks Dakinization Reverdin graft        | Amputation advised. Refused. Went home against advice. Well |
|                        | 61  | M   | Injury           | 2 days                                     | 97.9                  | 14,400                | 82                               | Hand          |   |                               | Hot water soaks Dakinization Reverdin graft            | Well  |
|                        | 40  | M   | Hypo. inj.       | 6 days                                     | 99.7                  | 18,300                | 72                               | Forearm       | Hem. strep.   | .....                         | Incision Dakinization Reverdin graft                   | Almost well   |
|                        | 30  | M   | Boil             | Approx. 14 days                            | 100.4                 | 16,000                | ..                               | Leg           | Hem. strep.   | .....                         | Incisions Hot water soaks Dakinization Reverdin graft  | Amputation of lower third of thigh. Well.                   |
|                        | 32  | M   | Ulcer            | 14 days                                    | 100.7                 | 10,500                | ..                               | Foot          | Hem. strep.   | Hem. strep.                   | Incisions Hot soaks Dakinization                       | Well  |
|                        | 32  | F   | None             | 7 days                                     | 103.3                 | 14,800                | 69                               | Arm           | Hem. strep.   | Neg.                          | Incisions Dakinization                                 | Well  |
|                        | 80  | M   | Boil             | 14 days                                    | 99.3                  | 8,500                 | 80                               | Forearm       | Hem. strep.   | Neg.                          | Reverdin graft Dakinization                            | Well  |
|                        | 44  | M   | None             | 15 days                                    | 100.4                 | 19,850                | 89                               | Thigh         | Hem. strep.   | Neg.                          | Reverdin graft Incisions                               | Well  |
|                        | 35  | M   | Boil             | 23 days                                    | 98.6                  | 12,000                | 67                               | Arm           | Hem. strep. Gram + B. (unidentified)                        | .....                         | Reverdin graft Incisions                               | Well  |
|                        | 54  | M   | Comp. fract.     | 3 days                                     | 95                    | 14,200                | 91                               | Wrist         | Hem. strep. Staph. aur. Gram + B. (unidentified)            | Hem. strep.                   | Reverdin graft Dakinization                            | Amputation of arm. Died (17th day)                          |
|                        | 17  | F   | Frostbite        | 15 days                                    | 99                    | 16,700                | 80                               | Foot          | Hem. strep. Nonhem. staph. aur. Gram + fusiform B.          | Pos. 9th day                  | Incisions Hot saline soaks Reverdin graft              | Well  |
|                        | 14  | M   | "Sprained" ankle | 14 days                                    | 102.5                 | 10,400                | 77                               | Foot          | Hem. strep. Nonhem. staph. aur. Hem. staph. aur. B. Welchii | Hem. strep.                   | Foot disarticulated at ankle                           | Amputation lower third of thigh. Died (5th day)             |
|                        | 25  | M   | Corn             | 4 days                                     | 103                   | 21,000                | 83                               | Foot          | Hem. strep.   | Pos. 2nd day                  | Incisions Hot water soaks Dakinization                 | Well  |
|                        | 33  | M   | Abrasion         | 16 days                                    | 101                   | 20,000                | 83                               | Leg           | Hem. strep.   | Neg.                          | Reverdin grafts Incisions Hot water soaks Dakinization | Wounds not healed.  |
|                        | 37  | M   | Hypo. inj.       | 17 days                                    | 100.6                 | 28,000                | 96                               | Arm           | Hem. strep. Staph. aur. B. pyocyane.                        | Hem. strep.                   | Thiersch grafts Incisions Hot soaks                    | Died (27th day)   |
|                        | 23  | M   | Scratch          | 7 days                                     | 100.2                 | 76,000                | 90                               | Forearm       | Hem. strep.   | Neg.                          | Incisions Hot soaks Dakinization                       | Well  |
|                        | 23  | M   | None             | 10 days                                    | 100.4                 | 19,200                | 82                               | Leg           | Hem. strep. G. + and G. - B.                                | Neg.                          | Reverdin graft Incisions Hot water soaks               | Well  |





Multiple incisions were made upon the right upper extremity at 11 P.M. under ether anesthesia. No tourniquet was used. An incision

The maximum temperature was 101°F. by rectum on the first postoperative day, following which it receded slowly until the eighth



FIG. 1. Photograph taken on the third day of illness (second postoperative day). Note the marked edema of right arm, chest wall and neck. The dusky discoloration of these areas is evident.

approximately five inches in length was made over the radial aspect of the forearm. The incision extended down to the muscle. No escape of gas was noted. A moderate amount of serum exuded from the wound. A smear and culture were made. There was no bleeding whatsoever. The subcutaneous tissue was deep purple in color. The fascia overlying the muscle was split and revealed normal appearing muscle tissue. A second incision of about the same length was made over the ulnar aspect of the forearm. Because of marked edema, retraction of the wound margins took place. Two similar incisions were made on the arm over the anterior and posterior aspects; exactly the same appearance of the tissues was noted. Only one bleeding vessel was encountered in making these four incisions. The chest wall was not incised. Eighty thousand units of penicillin were injected directly into the tissues of the arm, forearm and chest. Dry dressings were applied.

Following surgery, the patient continued to receive 10,000 units of penicillin every three hours until October 16th, making a total dosage of 5,200,000 units. He was also given 7.7 gr. of sulfadiazine every four hours during the day for the same length of time.

postoperative day, when it was normal and did not rise again above this level. Daily blood studies were made. The highest white cell count was 23,700 with 77 per cent polymorphonuclear leukocytes and 23 per cent lymphocytes on the second postoperative day. The total count gradually decreased and on October 18th the count was 9,800 with 24 per cent polymorphonuclear leukocytes and 76 per cent lymphocytes. The urinalyses were negative throughout the period of hospitalization.

Bacteriological studies consisted of anaerobic and aerobic cultures. Short chain, Gram-positive, non-hemolytic streptococci, *Staphylococcus albus* and an occasional Gram-negative long, thin rod, some of which appeared to be spore-bearing, were recovered from the anaerobic culture. The original aerobic culture did not show any growth. The non-hemolytic streptococcus appeared to be the predominant organism.

The wounds were dressed on the second postoperative day. A thin, serous drainage saturated the dressings. The subcutaneous tissue at this time presented a healthy, normal appearance and bled freely. The edema of the entire arm was slightly less pronounced. The discoloration was considerably less striking

than prior to operation. Sulfathiazole powder topically and dry dressings were used exclusively throughout the course of the illness.

of erythema. A zone of erythema which appears before the onset of the gangrene and extends beyond the area of dusky

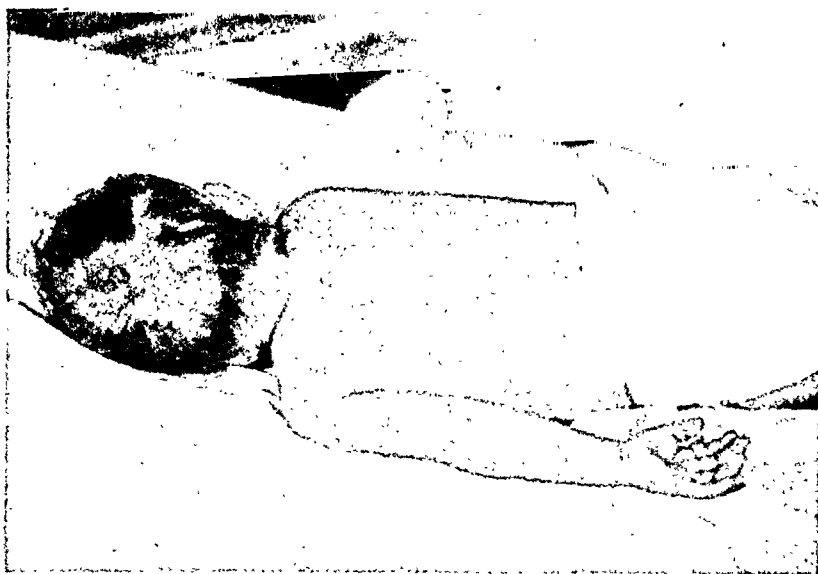


FIG. 2. Photograph of back taken on the same day. Dusky discoloration of the upper portion of the back and left shoulder is present.

On October 10th it was noted that swelling and discoloration of the chest wall had progressed. Swelling and purplish mottling of the neck were observed for the first time on the morning of this date. (Fig. 1.) At this time considerable edema and discoloration of the entire left shoulder region and the posterior chest wall as far as the costal margin were noted. (Fig. 2.) The intensity of the discoloration of these latter areas was more pronounced than that observed on the right arm at any time. The discoloration reached its maximum intensity on October 15th, following which it began to fade gradually in all areas. On October 11th the edema of the anterior chest wall and neck was more marked. Recession of the edema did not begin until October 12th.

At the time of the patient's discharge from the hospital on October 23rd, the edema and discoloration of all the involved regions had disappeared entirely. Very little drainage of the wounds was evident. The drainage ceased entirely on November 21st. There was no disability of the right upper extremity.

#### COMMENT

The case presented differs from all the cases of mixed bacterial or streptococcic gangrene recorded in the literature by one outstanding feature, namely, the absence

discoloration has been emphasized as a predominant finding in all the reports. We believe, however, that there can be no doubt that our case is one of mixed streptococcic and staphylococcic gangrene. It is possible that the absence of the hemolytic streptococcus accounts for the absence of the erythematous stage of the disease.

The therapeutic regimen recommended in the literature consists of multiple incisions of all discolored areas, followed by Dakinization or various types of wet dressings. The sloughs should be removed and the denuded areas grafted with skin. It should be emphasized that in our case no sloughs occurred. In view of the locally destructive changes and the mortality rate of 18 per cent of the cases hitherto reported, it is believed that the excellent result obtained in our case was due to the very early and thorough treatment with penicillin and sulfadiazine.

It is interesting to speculate what might have been the outcome in our case if surgery had been omitted and sole reliance placed on penicillin and sulfadiazine. It was pointed out that the chest, neck, left

shoulder and back, which were not treated surgically, responded favorably to sulfadiazine and penicillin. These areas were eventually more edematous and discolored than the right arm which was incised. Meleney<sup>1,9,16</sup> insists that all the discolored areas be incised up to but not through the zone of erythema. It is possible that the armamentarium of penicillin and sulfadiazine alone may suffice for the control of early infection, thus making mutilating incisions unnecessary.

Cases of mixed bacterial or hemolytic streptococcal gangrene are rare. Nevertheless this disease must be considered in the differential diagnosis of acute gangrene of an extremity. Where crepitation of the tissues is not elicited, appropriate treatment should not await the outcome of bacteriological studies which may require several days. The diagnosis must be made upon a clinical basis and treatment instituted as soon as possible.

#### SUMMARY

1. A discussion of mixed bacterial acute gangrene of an extremity is presented.
2. A review of recorded cases is prepared in tabulated form.
3. A case of mixed bacterial acute gangrene of an extremity treated by multiple incisions, penicillin and sulfadiazine is reported in detail.
4. No sloughing of the tissues occurred with this regimen, in contrast to the disfigurement which resulted in all cases treated by the previous methods.

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# SURGICAL ASPECTS OF CERTAIN BLOOD DYSCRASIAS

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THERE are certain blood dyscrasias that respond miraculously to surgery.

There are others for which surgery gives palliative relief, and there are still others for which surgery offers nothing. Surgery in these blood dyscrasias is limited mainly to splenectomy. The spleen has been called an organ of mystery, but it is not essential to life, because following its surgical removal its function is adequately taken over and compensated for by other tissues of the body. A splenectomy should never be done in the treatment of blood dyscrasias unless the surgeon has a thorough knowledge of these diseases and has adequately studied the case in question.

The spleen is a complex organ, and its functions are many. Its physiology is very complex. Suffice it to say that of its many and varied duties the following are of importance in its relation to blood dyscrasias: (1) In fetal life the spleen is one of the sources of formation of practically all of the blood elements. (2) It plays a very important part in blood destruction, since the spleen contains large numbers of reticulo-endothelial cells. (3) It has some regulatory action on the fragility of the blood, probably through the secretion of a hormone that in some way, generally or locally, may affect hematopoiesis. (4) In some unknown fashion it is concerned with the formation or destruction of platelets. (5) Being a part of the reticulo-endothelial system it is concerned with disturbances of lipid metabolism.

There are much experimental data to substantiate these assumptions. In all of the blood dyscrasias a perversion of the reticulo-endothelial system is present to some extent. The thought has recently

arisen that this perversion may have as a part basis nutritional faults such as vitamin B and C deficiencies.

*Familial Hemolytic Anemia.* This is the first blood dyscrasia that we wish to mention that responds nobly to splenectomy. This condition is a chronic familial and congenital anemia characterized by jaundice, splenomegaly, increased fragility of the erythrocytes, spherocytosis of the red cells, and the occurrence of "crises." These crises are characterized by attacks of nausea and vomiting accompanied by pain over the spleen, deepening of the jaundice, chills and fever. The splenic enlargement, the characteristic microscopic picture of red blood cell engorgement in the spleen, with large amounts of hemosiderin, and the marked improvement following splenectomy in typical cases all indicate that hyperfunction of the spleen plays a prominent part in the excessive blood destruction in this disease. As a rule, splenectomy is followed by the disappearance of all symptoms, but usually the increased fragility and spherocytosis of the red cells persists. In many cases gallstones are present in the gallbladder, and cholecystectomy is here indicated. During the past year the junior author reported three cases in one family on which splenectomies were performed with excellent results.

*Idiopathic or Primary Thrombocytopenic Purpura.* This is the second blood dyscrasia for which splenectomy offers excellent results. Clinically this is a disease of early life, and it is often familial in nature. Its outstanding characteristics are a tendency to bleed easily and excessively into the skin and from the mucous membranes, splenomegaly in a large percentage

of the cases, and a marked diminution in blood platelets. Examination of the blood reveals in addition to a low platelet count a prolonged bleeding time, a normal coagulation time, and absence of clot retraction. The disease may be acute or chronic in nature, the latter being characterized by remissions. A widely accepted theory as to the etiology of this disease is that excessive thrombocytolytic activity of the spleen causes an increase in platelet destruction.

Splenectomy in this disease, first advocated by Kaznelson in 1916, offers brilliant results. Temporary improvement may be noted following medical treatment, but relapses always occur. The optimum time for operation is during the quiescent period, and the best results are obtained when splenectomy is performed following the first bleeding episode. Whether or not to operate in the acute form of purpura is a controversial point, but sometimes it is a necessity. If operation is performed in the acute phase, it should be done before the patient has bled to the point that he is a poor operative risk.

On the other hand, splenectomy is not indicated but is rather contraindicated in secondary thrombocytopenic purpura due to severe infections or intoxications. The treatment here lies in satisfactorily attempting to control the disease or factor which is causing the platelet destruction.

*Splenic Anemia.* This third disorder also responds brilliantly to splenectomy if the latter is done early in the disease. Many cases are thus permanently cured, and many more lead useful lives for long periods of time. As Osler stated, "splenic anemia is an intoxication of unknown nature characterized by great chronicity, progressive enlargement of the spleen which cannot be correlated with any known cause, anemia of the secondary type with leukopenia, a marked tendency to hemorrhage, particularly from the stomach and esophagus, and in many cases a terminal state with cirrhosis of the liver and jaundice." This entire symptom com-

plex is known as Banti's disease, whereas the diagnosis "splenic anemia" is justified when the early phenomena of splenomegaly and secondary anemia exist. Many authorities believe that in this disease the spleen exerts in some way a depressing effect on bone marrow activity. That the spleen plays a great rôle in this disease process is shown by the cures resulting from splenectomy in early cases.

At any time in the course of the disease splenectomy is imperative. The earlier the operation, the greater the chance for cure. Operation even after cirrhosis of the liver has appeared offers many excellent results. When splenectomy is performed ligation of the coronary vein is worthy of a trial. Even if operation is performed in early cases, gastrointestinal hemorrhage is a frequent postoperative occurrence.

Gaucher's disease, although primarily a disease of lipid metabolism, should be considered under the blood dyscrasias because of the changes present in the peripheral blood and changes in the reticulo-endothelial system of which the spleen is the largest reservoir. This disease is characterized by marked splenomegaly without ascites, moderate hepatic enlargement, lymphadenopathy, bronzed pigmentation of the exposed skin and a familial tendency. Blood examination reveals a hypochromic anemia and leukopenia. This is a disease of early life and runs a slowly progressive course, but may terminate quickly due to some intercurrent disease. Diagnosis may be established by splenic or bone marrow puncture for large vacuolated cells known as Gaucher's cells, by lymph gland biopsy or x-ray examination of the bones. A disturbance in lipid metabolism is only one phase of this disease, but the exact nature of this disturbance is unknown. In this disease the destructive action of the reticulo-endothelial system is exaggerated. Splenectomy offers no hope of cure, but it is a good palliative measure when there exists a

large burdensome spleen with thrombocytopenia and a hemorrhagic diathesis.

The second blood dyscrasia for which splenectomy is an excellent palliative measure, but not a cure, is VonJaksch's anemia. Clinically this condition is usually congenital and common to children of the Mediterranean races. It is characterized by marked splenomegaly, some hepatic enlargement, pallor or jaundice of the skin, enlargement of the peripheral lymph nodes, and enlargement of the facial bones giving the child a Mongolian appearance. Blood examination reveals a marked increase in young nucleated red cells with a marked change in their shape and size, a moderate anemia, and a leucocytosis with a relative lymphocytosis. This dyscrasia is a disease of abnormal hematopoiesis and runs a chronic, progressive, fatal course. Splenectomy simply relieves the child of the annoyance of a progressive splenomegaly.

There are other blood dyscrasias for which splenectomy has been performed such as pernicious anemia and polycythemia vera. The miraculous results obtained in pernicious anemia by the use of liver have pushed splenectomy into the background. Phenylhydrazine and irradiation offer the greatest possibility of cure to the polycythemia patient, and splenectomy has not given the results here to make it a standard method of treatment.

Recently on the surgical service of the senior author at the Abington Memorial Hospital there have been two patients with thrombocytopenia. These cases are briefly reviewed because they teach a definite lesson to the surgeon.

#### CASE REPORTS

**CASE 1.** This patient was a fifteen year old white male who was admitted to the hospital because of repeated attacks of epistaxis. On admission he was bleeding from the nose and gums. The Rumpel-Leed's tourniquet test was positive, and the spleen was not palpable. Blood studies were typical of thrombocyto-

penic purpura, no platelets being demonstrable. No intoxication or infection which might explain the platelet absence was demonstrable. The patient's condition became very precarious, the bleeding became more free and generalized. A splenectomy was performed although the patient was nearly moribund. The spleen was enlarged to twice the normal size. Following operation the platelet count rose to 50,000 on the sixth postoperative day, the bleeding time decreased, and the hemorrhagic diathesis stopped. An interesting feature of this case was that a preoperative bone marrow biopsy showed a reduction of megakaryocytes, and that the megakaryocytes present were abnormal. This pointed to the fact that the etiology of the thrombocytopenia was an impaired formation of the megakaryocytes which are the precursors of platelets. Splenectomy, theoretically would be to no avail here. However, it was done as a life-saving procedure, and the result was just that.

**CASE 11.** The second patient was a sixty-three year old white male admitted to the hospital because of hemoptysis, a generalized rash and abdominal pain. It was found that he had long suffered from sinus trouble, and in the distant past had received anti-luetic therapy. Examination revealed: (1) a rash on all extremities; (2) a maxillary sinusitis; (3) splenomegaly; (4) moderate hepatomegaly. Blood studies revealed: (1) a leucocytosis of 19,500; (2) a platelet count of 57,000; (3) normal bleeding and coagulation times. Following admission he bled freely from his right ear. This man was suffering from a secondary thrombocytopenic purpura secondary to a maxillary sinusitis. He responded well to drainage of the sinuses, blood transfusions, high caloric, high vitamin diet, and other appropriate medical therapy.

These two cases are excellent examples of the two types of thrombocytopenic purpura. In the first case splenectomy was indicated and was done. A remarkable recovery followed. Splenectomy was not indicated, but rather contraindicated, in the second case. Operation might have caused a fatality. Therefore, it is essential to study the blood dyscrasia in question thoroughly, and be sure that operation is indicated before any such procedure is undertaken.

## SUMMARY AND CONCLUSIONS

1. The important functions of the spleen in relation to blood dyscrasias are mentioned.

2. Splenectomy offers excellent results in familial hemolytic anemia, primary thrombocytopenic purpura and Banti's disease.

3. Splenectomy offers palliative relief in Gaucher's disease and VonJaksch's anemia.

4. Two cases of thrombocytopenic purpura are reviewed.

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WHATEVER may be the cause of shock, it must be insisted upon that the condition is a *failure of the circulation*. Clinically this is shown by a fall of blood pressure. The fall in blood pressure follows, rather than initiates, the onset of shock. It will occur only when the compensatory mechanism of the body which maintains the circulation commences to break down.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).



# PRIMARY REPAIR OF THE PAROTID DUCT\*

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**D**IVISION of the parotid duct frequently results in a distressing salivary fistula. The saliva from the corresponding parotid gland drains orifice of the duct opposite the upper second molar tooth. (Fig. 1.) The strand is anchored to the buccal mucosa from within the mouth with a single suture.

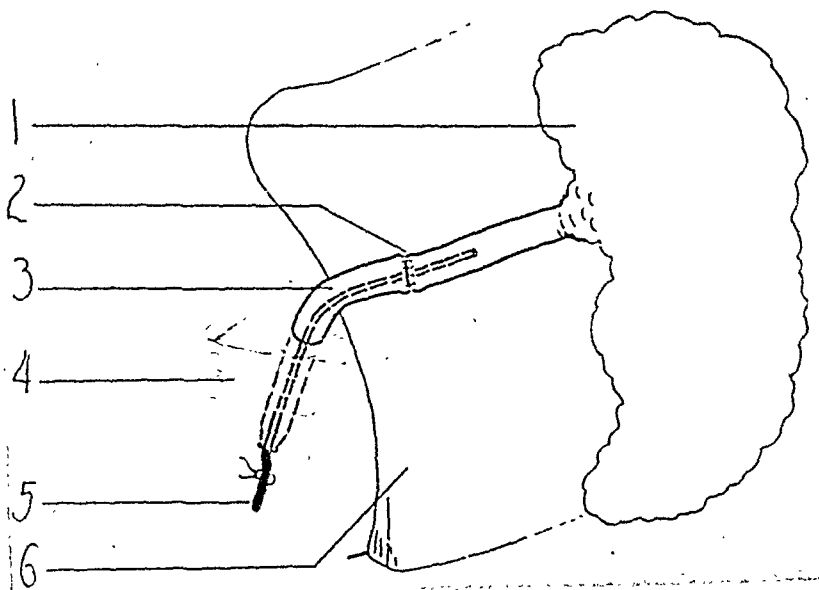


FIG. 1. Diagram of parotid duct repair: 1, parotid gland; 2, line of division; 3, parotid duct; 4, buccinator muscle; 5, silkworm gut dowel sutured to buccal mucosa; 6, masseter muscle.

through the scar onto the cheek. This can be prevented by a primary repair of the parotid duct.

The important points in the successful repair of the duct are early repair, the use of an inlying dowel, and the fixation of this dowel until healing of the duct occurs. The ends of the severed duct are identified. A strand of silkworm gut is passed into the proximal end to the most medial portion of the parotid gland. The remainder of the strand is passed into the distal severed end, through the distal portion of the duct and into the mouth through the oral

The silkworm gut dowel acts as an internal splint and facilitates accurate approximation. A similar technic has been used for the repair of a parotid duct fistula.<sup>3</sup> In that case the dowel was anchored to the second molar tooth.

The following dowels have been used: a strand of catgut,<sup>6</sup> a strand of silkworm gut,<sup>5</sup> a ureteral catheter,<sup>1</sup> a filiform ureteral bougie,<sup>2</sup> and a strand of horsehair.<sup>4</sup> The method of fixation of the dowel to the buccal mucosa presented in this case is simple and satisfactory. Brohm and Bird<sup>2</sup> fixed the dowel by passing it back out

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through the cheek and suturing it to the skin.

#### CASE REPORT

Hospital No. 32658. A thirty year old colored male entered Roper Hospital September 23, 1944, soon after sustaining a laceration of the face from 3 cm. anterior to the ear on the zygoma to the chin. After thorough preparation and under local anesthesia, the ends of the parotid duct were identified. The division was in the middle, or masseteric, portion. A laceration in the masseter muscle underneath the parotid duct was repaired after sulfathiazole crystals were instilled.

A strand of silkworm gut was passed for 1 cm. into the proximal severed end of the parotid duct. The remainder of the strand was passed into the distal severed end into the oral cavity. The silkworm gut was sutured to the buccal mucous membrane near the oral orifice of the parotid duct with a single suture. (Fig. 1.)

The ends of the duct were approximated by uniting the fascial sheath with a single layer of interrupted cotton sutures. The laceration

was closed without drainage with interrupted cotton sutures. Per primam healing occurred. The silkworm gut was removed on the seventh day. At a follow-up visit two weeks later in the out-patient department, no external or internal fistula was present. There was no pain or swelling of the parotid gland after meals. The result appeared to be entirely satisfactory.

#### SUMMARY

Primary repair of the parotid duct is discussed, and a case presented.

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# Selected Book Reviews

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AS a rule a good and needed work goes through a process of editorial and publishing evolution; the mistakes and omissions in the original published text are corrected and balanced in subsequent editions. This is not especially true of Titus's work.<sup>1</sup> He did an adequate and thorough job in the first edition (1937); and although he has brought the work up to date in the second edition and made changes and additions (science never stands still, not even obstetrics . . . as old as man), in either edition the book is outstanding in its field.

Many physicians just "have" to do midwifery. If everything is normal, and the labor is normal with a mother and baby normal, and a fairly normal birth is the outcome, the physician gives a sigh of relief and emerges from a panic of apprehension. But all births are not normal. The pathway of labor is one of many cul-de-sacs and pitfalls. It is well for the physician to know when he is in trouble, when to call for expert aid, or, better still, know how to meet and solve the difficulty.

Therefore, to all who are obstetricians or "do obstetrics" we urge they own this work, which is a successful effort to develop a practical aid for those who are meeting and contending with obstetrical difficulties. It is not a conventional textbook, but to advanced students, residents and young practitioners (in fact, to all but the expert) it will prove an invaluable help.

There is no need to review the scope of the contents. Suffice that it covers the subject, that it has been written by a recognized authority, and in every way should be labelled "standard and outstanding."

Although the medical journals of the country have given the subject of pain in childbirth frequent and wide space, we, nevertheless, are of the opinion that every physician who "does obstetrics" (with a few reservations) would do well to read, reread and

<sup>1</sup> The Management of Obstetric Difficulties. By Paul Titus. 2nd ed. St. Louis, 1945. C. V. Mosby Company. Price \$8.50.

study parts of Lull's book.<sup>2</sup> It covers thoroughly the subject of the control of pain in childbirth.

As is well known, there are many methods or ways to lessen or abolish pain in childbirth. Because the lay public demands the control of this pain, many physicians resort to one or more measures in order to be labelled modern and to curry favor with "women who bear children." Some methods are comparatively safe, both to mother and baby; others are all right if they work and nothing untoward ensues; some methods call for experience and great technical skill; in others a skilled anesthetist must be called. In order to evaluate these many methods, know the history and growth of man's attempt to control the pain of bearing offspring in the human, become familiar with the various methods and technics of administering various drugs, and being made aware of the end-results, we urge that this book be studied. It covers all forms of anesthesia, analgesia and amnesia, and has a complete set of charts that show the effects of the various drugs on both the maternal and fetal organs.

The book is wholeheartedly recommended. It is profusely illustrated, and the publishers have done well to offer it at a comparatively low price, when today one considers the costs of illustrations in color, with which this book abounds.

We are told that thirty-six of the thirty-seven collaborators in *Principles and Practice of Surgery*<sup>3</sup> work together in the hospital and medical school of Temple University. It is a truism that the work mirrors the latest surgical advances and offers the reader a concise text despite the large amount of material on the nature, diagnosis and modern treatment of all surgical conditions. Wounds acquired in war and in civil life and the injuries and infections sustained from animal and vegetable parasites and viruses are given adequate space. Treatment is given in great detail. But we have not the space to tell of the many surgical fields and byways covered. The subject is covered and in detail, as noted by the scope of its Four Parts: General Surgery, Surgical Technique, The Surgery of Systems and Regional Surgery.

This book is unique in that it is so uniform in its smoothness and

<sup>2</sup> *Control of Pain in Childbirth*. By Clifford B. Lull and Robert A. Hingson. Philadelphia, 1944. J. B. Lippincott Company. Price \$7.50.

<sup>3</sup> *Principles and Practice of Surgery*. By W. Wayne Babcock. Philadelphia, 1944. Lea & Febiger. Price \$12.00.

dovetailing, especially when one considers its many co-authors. Doctor Babcock has done an excellent bit of both writing and editing, and the text should find space on your bookshelf.

Those interested in clinical roentgenology of the digestive tract will welcome a second edition of Feldman's book<sup>4</sup> because the first edition was well received and was found sound and worth while.

This new edition, thoroughly revised and completely reset is (we read and agree) "essential for the roentgenologist and gastroenterologist, as well as the internist (and we add, the surgeon) who not satisfied merely to accept the reports of others, wishes to satisfy himself about the interpretation of gastrointestinal films." With this we agree only with reservations. We believe a well trained and experienced roentgenologist, in the last analysis, is the man to lean on. His diagnosis and advise should be accepted. It is common practice in many hospitals (especially those with a well equipped x-ray department, usually in the larger hospitals) for the internist and surgeon to stand by while the roentgenologist describes what he sees and builds up to the "why" of his diagnosis. Some internists and surgeons become quite expert in this work, and now and then venture to air their own opinions and deductions. This work will prove of great value to this class of practitioner. Also, it will be found a gold mine to the student, the junior physician learning the art of reading films, and anyone else interested in knowing how to make a diagnosis, or associate the clinical findings of trouble in the digestive tract with what is revealed in a roentgenological film.

This is a large book, 769 pages; there are 551 figures; throughout the text References are given; and there is an ample Index.

Naturally Golden's<sup>5</sup> work will be of interest to radiologists, but the surgeon and internist who knows how to read films will find it time well spent in going through its pages. The author does not attempt to be all inclusive in his discussion from the standpoint of the pathologist, anatomist and physiologist; neither does he discuss the treatment of disease of the small intestine.

The material has been assembled over a period of years. Many instructive cases have been sent the author by colleagues from all

<sup>4</sup> Clinical Roentgenology of the Digestive Tract. By Maurice Feldman. 2nd ed. Baltimore, 1945. The Williams & Wilkins Company. Price \$7.00.

<sup>5</sup> Radiologic Examination of the Small Intestine. By Ross Golden. Philadelphia, 1945. J. B. Lippincott. Price \$6.00.

parts of the country. In fact, much of the material comprising the text has been presented at instructional courses at meetings of the American Roentgen Ray Society and the Radiological Society of North America.

The book covers such subjects as The Normal Small Intestine Roentgen Examination. The Small Intestine of the Infant, Peritoneal Adhesions and Ileus, The Miller-Abbott Tube in the Diagnosis and Treatment of Ileus, Disorders of Nutrition, Diseases of the Mesentery, Allergy, Inflammations, Neoplasms, Certain Conditions of Developmental Origin, Some Effects of Food on the Small Intestine, Effects of Certain Drugs, and Miscellaneous Conditions, such as External Hernia, Excessive Food in the Jejunum, Emotion, Acquired Diverticula, Simple Ulcer, and so forth.

There are 183 subjects and seventy-five figures, as well as an ample Bibliography and Index.

Caldwell's manual<sup>6</sup> containing 303 pages and ninety-two illustrations, is a worth while book on the treatment of fractures, especially at this time when so many war casualties are being handled.

The author tells us that so much has been written and so many mechanical gadgets and splints have been described that the average practitioner finds it difficult to evaluate them. Therefore, he has aimed, and successfully, to suggest or describe one or two procedures for each of the common types of fracture which have given satisfactory results in his experience. Special stress has been given to compound fractures and the use of the sulfonamides in the prevention and treatment of infections. For the sake of simplicity and clarity in illustration, line drawings have been used throughout; some have been redrawn from current textbooks.

Every young physician in the armed forces and every practitioner, who is called upon as the first person to diagnose and treat fractures, would do well to read and read carefully this well written and concise work.

First of all congratulations to the Publisher who has provided a good looking book<sup>7</sup>—good paper, well printed, and the illustrations (234) exceptionally well done.

<sup>6</sup> Treatment of Fractures. By Guy A. Caldwell. New York, 1943. Paul B. Hoeber, Inc. Price \$5.00.

<sup>7</sup> Neuro-Ophthalmology. By Donald J. Lyle. Springfield, Ill., 1945. Charles C. Thomas. Price \$10.50.

Naturally, this work will appeal in the main to ophthalmologists but the well read physician, internist or surgeon, would do well to dip now and then between its covers.

The book deals with the relationship of the eye to the brain, showing the effect of certain diseases of the brain on the eyes. Thoroughly covered are such subjects as the Embryological Development of the Neural Structures of the Eye, The Visual System, The Visual Cortical Areas of the Brain and Associated Tracts and Motor Nerves of the Eye, The Sensory Nerves to the Eye, The Auditory Nerves, Ocular Reflexes, The Cerebrospinal Fluid System of the Brain, Meningitis and Brain Abscess, Syphilis of the Central Nervous System, Eye Manifestations of Head Injuries, and other interesting and important topics.

There is a Bibliography and Index, and attached to the inside back cover an envelope containing Charts for Recording Lesions Affecting the Visual System.

"The New York Hospital"<sup>8</sup> was written by the Emeritus Professor of Psychiatry, Cornell University Medical College. To workers in his field he needs no introduction. But this book in no wise is a scientific volume. It deals purely with the history of the psychiatric service at The New York Hospital covering a period of one hundred sixty-five years. And to anyone interested in the subject of psychiatry or the historical aspects of medicine in America, this book is one warmly recommended. It will reward the owner or reader with many delightful hours, for it makes for good reading.

We are given an account of the earliest provision for hospital treatment of the mentally ill in the State of New York, which project was instituted in 1771. We are told that although many public institutions subsequently provided for medical care of the mentally ill, New York Hospital pioneered in both public and private care and is today one of only a dozen voluntarily supported hospitals in America offering such treatment.

Five hundred fifty-six pages long, the work is profusely illustrated, and has an Index that shows painstaking care.

Teachers and students of psychiatry and mental hygiene and those interested in social history, as well as the history of psychiatric nursing education, and public welfare, will find this work a "must"—for reading and a good book to own.

<sup>8</sup> The New York Hospital—A History of the Psychiatric Service 1771–1936. By William Logie Russell. New York, 1945. Columbia University Press. Price \$7.50.

# AUTHOR INDEX TO VOLUME LXX

- Abbott, William E., 369  
 Akopiantz, Levon A., 128  
 Allen, Frederick M., 283  
 Altemeier, W. A., 258  
 Angelo, Gaspar, 354  
 Bandler, Clarence G., 337  
 Barber, Robert F., 135  
 Beck, Carl, 137  
 Behan, R. J., 268  
 Berman, Harry, 121  
 Berman, Jacob K., 360  
 Bernstein, Phineas, 164  
 Bisgard, J. Dewey, 95  
 Blumberg, Nathan, 38  
 Bortone, Frank, 64  
 Botsford, Thomas W., 153  
 Brown, Chester W., 4  
 Burgess, C. M., 237  
 Caylor, Harold D., 133  
 Cianfrani, Theodore, 100  
 Cohn, Bernard N. E., 401  
 Collings, G. H., Jr., 58  
 Conrad, Harold A., 109  
 Copleman, Benjamin, 197  
 Curry, G. J., 243  
 Daughtry, DeWitt C., 374  
 Downey, James W., 86  
 Eaton, Chelsea, 83  
 Ellis, Ralph C., 389  
 Falk, Henry C., 176  
 Ferguson, L. Kraeer, 139  
 Fett, Herbert C., 234  
 Fish, James E., 109  
 Foley, William J., 105  
 Foote, Robert F., 234  
 Friedman, Emanuel, 401  
 Fruhlinger, Ben, 126  
 Gardner, W. James, 232  
 Garipey, Louis J., 386  
 Glaser, Mark Albert, 249  
 Goldstein, Albert E., 13  
 Gordon, Charles A., 277  
 Granet, Emil, 139  
 Grayzel, David M., 394  
 Harrison, John H., 153  
 Hawkins, B. L., 383  
 Helfrick, J. Rembrandt, 131  
 Hellendall, Hugo, 320  
 Henley, Paul G., 386  
 Hochman, Samuel, 176  
 Hoffman, Burton P., 394  
 Horner, H. Ogle, 201  
 Jenkins, H. B., 118  
 Kaplan, I. W., 383  
 Kirschbaum, Harry M., 134  
 Klotz, Ben, 13  
 Krida, Arthur, 275  
 Lazarus, Joseph A., 114  
 Leveton, Albert L., 49  
 Lowenberg, Eugene L., 291  
 Madden, John L., 135  
 Mainella, Frank, 121  
 Marks, Morris S., 114  
 McClintock, Leslie A., 4  
 McClure, Roy D., 1  
 McCriston, C. C., 237  
 McGregor, Mar W., 249  
 Melick, Dermont W., 364  
 Merkle, H. J., 68  
 Migliaccio, A. V., 261  
 Mintz, Bernard J., 189  
 Neary, Edward R., 4  
 Ovens, J. M., 24  
 Patterson, F. M. Simmons, 408  
 Pfeiffer, Damon B., 408  
 Pollock, Boris, 227  
 Posch, Joseph L., 369  
 Ratzan, Martyn C., 213  
 Reich, Walter J., 341  
 Robertson, George E., 95  
 Roen, Philip R., 337  
 Rubin, Leonard R., 302  
 Schimmel, Irwin, 308  
 Schmier, Adolph A., 27  
 Seitz, V. B., 232  
 Sibley, William L., 79  
 Silverman, Harold E., 341  
 Simon, Harold E., 86  
 Smith, Orland F., 158  
 Stept, Raymond, 337  
 Thompson, S. A., 213  
 Thompson, Samuel Alcott, 227  
 Trichel, Burdette E., 153  
 Wallace, F. T., 412  
 Weckesser, Elden C., 184  
 White, J. William, 389  
 Wilkey, J. Lester, 341  
 Williams, H. G., 24  
 Wilson, Harwell, 255  
 Witwer, Lee, 133  
 Zisserman, Louis, 38



# SUBJECT INDEX TO VOLUME LXX

(Bo.B.) = Bookshelf Browsing; (E.) = Editorial

**A** bdomen, perforation of wall of, 386

Abortion, criminal, 100

Abscess

and appendicitis, 386

brain, and meningitis, 249

Brodie's, 86

Abscesses, management of, 139

Ambulation, early, after operation (E.), 1

Amputations, war, treatment of, 184

Anesthesia

obstetrical, intravenous, 283

refrigeration, 201, 364

Appendicitis, suppurative, and abscess, 386

Appendix

polyps of, 389

vermiform, diverticulitis of, 258

Arch, zygomatic, fracture of, 27

Artery, brachial, thrombosis of, 255

Aspects

historical, of cardiac resuscitation (Bo.B.), 135

surgical, of blood dyscrasias, 408

**B** lock, cervical, sympathetic, for thrombosis, 255

Blood dyscrasias, 408

Bone, zygomatic, fracture of, 27

Bones, fetal, passed in feces, 126

Book Reviews:

*Clinical Roentgenology of the Digestive Tract*, 416

*Control of Pain in Childbirth*, 415

*Management of Obstetric Difficulties*, 414

*Neuro-Ophthalmology*, 417

*New York Hospital—A History of the Psychiatric Service 1771–1936*, 418

*Principles and Practice of Surgery*, 415

*Radiologic Examination of the Small Intestine*, 416

*Treatment of Fractures*, 417

Brain abscess and meningitis, 249

Brodie's abscess, 86

Burns, treatment of, 58

**C** ast, hanging, use of, 369

Cause of maternal death, 277

Chlorophyll for burns, 58

Cholecystitis, gangrenous, 38

Colon, lipomas of, 114

Condition, proctologic, 354

Conditioned to disc (E.), 275

Control of thyroid storm, 308

Correction of stress incontinence in female, 341

Cure of ingrown toenails, 79

Cyst, thyroglossal, excision of, 118

Cysts, management of, 139

**D** eath, maternal, and hemorrhage, 277

Defects, hearing, stethoscope for doctors with, 134

Derangements, internal, of knee, 189

Device for ends of Kirschner wires, 133

Diagnosis, salpingography in, 164

Diaphragm, eventration of, 95

Disc, conditioned to (E.), 275

Disease, pilonidal, 139

Disk, intervertebral, herniated, 24

Diverticulitis of vermiform appendix, 258

Diverticulum, esophageal, 64

Dressing, traction, 232

Duct

common, reconstruction of, 261

parotid, repair of, 412

Duodenum, tumors of, 394

Dyscrasias of blood, 408

**E** lbow, excision of, 243

Esophagus, diverticulum of, 64

Eventration, congenital, of diaphragm, 95

Excision

of elbow for fractures, 243

of thyroglossal cyst, 118

Exploration of sinus and fistulous tracts, 197

Extract, adrenal, cortical, for burns, 58

Extremity, gangrene of, 401

**F** atigue fractures, 49

Feces, fetal bones passed in, 126

Female, incontinence in, 341

Femur, fractures of, 369

Fistula

fecal, in gynecological surgery, 176

of submaxillary gland, 118

Fixation pins, device for ends of, 133

Fluid, amniotic, instillation of, 68

Fracture

compound, and excision of elbow, 243

metatarsal, 49

of femur, 369

of zygomatic bone and arch, 27

Fusion, spinal, and herniated disk, 24

**G** angrene of extremity, 401

Giant cell xanthoma of knee joint, 234

Gland, submaxillary, fistula of, 118

Grafting of skin, 302

Grafts, omental, in thorax, 227  
 Granulocytopenia and sulfatherapy, 109  
 Gum acacia in skin grafting, 302

**H**eadgear, postoperative, 27

Hemorrhage as the cause of maternal death, 277  
 History of cardiac resuscitation (Bo.B.), 135  
 Holder for needle, 128  
 Hypoproteinemia in surgery of thorax, 213

**I**ncontinence, urinary, in female, 341

Infections, surgical, 4

Injury  
   intestinal, 109  
   and fecal fistula, 176

Intestine  
   injury to, in gynecological surgery, 176  
   small, lymphosarcoma of, 121

Intussusception  
   and lipomas of colon, 114  
   diagnosis and treatment, 158

**J**oint, knee, xanthoma of, 234

**K**irschner wires, device for ends of, 133

Knee  
   derangements of, 189  
   joint, xanthoma of, 234

**L**igation of supernumerary ureter, 13

Lipomas, submucous, of colon, 114  
 Lymphogranuloma venereum, 320  
 Lymphosarcoma of small intestine, 121

**M**ale urethra, stricture of, 153

Management  
   surgical, of eventration of diaphragm, 95  
   of femoral vein thrombosis, 291

March fractures, 49  
 Medicine, Pre-Columbian (Bo.B.), 268  
 Meningitis and brain abscess, 249

Mixture of urea-sulfanilamide, 4  
 Modification  
   of operation for ingrown toenails, 79  
   of trocar method of instillation, 68  
 Mortality, maternal, and hemorrhage, 277

**N**avy, pilonidal disease in, 139

Needle holder, 128

**O**bstetrics, intravenous anesthesia in, 283

Operation

  early ambulation after (E.), 1  
   for ingrown toenails, 79  
   instillation of amniotic fluid at close of, 68  
   newer trends after, 374

**P**arotid duct, repair of, 412

Patients with proctologic conditions, 354

Penicillin

  for brain abscess, 249  
   for gangrene of extremity, 401  
   in intestinal injury, 109

Perforation of abdominal wall, 386

Phthalylsulfathiazole-'sulfathalidine,' 354

Placenta, lymphogranuloma venereum in, 320

Polyps of appendix, 389

Pre-Columbian middle America medicine (Bo.B.), 268

Prostate, resection of, 337

Puerperal deaths in Brooklyn, 277

**R**econstruction of common duct with vitallium, 261

Refrigeration anesthesia, 201, 364

Removal of herniated disk, 24

Repair of parotid duct, 412

Resection of prostate and thrombin (topical), 337

Resuscitation, cardiac, history of (Bo.B.), 135

Retractor, anal, 131

**S**alpingography in surgical diagnosis, 164

Simplification of split skin grafting, 302

Sinus

  exploration of, 197  
   pilonidal, treatment for, 360

Sinuses, management of, 139

Skin grafting, simplification of, 302

Spine fusion and herniated disk, 24

Steinmann's pin, device for ends of, 133

Stethoscope for doctors with hearing defects, 134

Storm, thyroid, control of, 308

Stricture of male urethra, 153

Study, clinical, of supernumerary ureter, 13

Sulfadiazine

  for brain abscess, 249  
   for gangrene of extremity, 401  
   in intestinal injury, 109

Surgery

  after war (E.), 137  
   anorectal, retractor for, 131  
   gynecological, 176  
   in femoral vein thrombosis, 291  
   of thorax, 213

**T**endovaginitis, bicipital, 383

Testicle, torsion of, 105

## Thorax

- omental grafts in, 227
- surgery of, 213

## Thrombin (topical) in resection of prostate, 337

## Thrombosis

- of brachial artery, 255
- of femoral vein, 291
- postoperative, of iliac vein, 237

## Thyroid storm, control of, 308

## Toenails, ingrown, cure of, 79

## Torsion of testicle, 105

## Traction, constant, dressing, 232

## Tracts, fistulous, exploration of, 197

## Transmission of lymphogranuloma venereum through placenta, 320

## Treatment

- for pilonidal sinus, 360
- of burns, 58
- of derangements of knee, 180
- of infections with urea-sulfanilamide, 4
- of intertrochanteric fractures of femur, 369
- of intussusception, 158
- of war amputations, 184

## Trends, postoperative, 374

## Trocac method for instilling amniotic fluid, 68

## Tubes, vitallium, for reconstruction of duct, 261

## Tumors of duodenum, 394

## Ureter, supernumerary, 13

## Urethra, male, stricture of, 153

## Use of free omental grafts in thorax, 227

## Value of salpingography in diagnosis, 164

## Vein

- femoral, thrombosis of, 291
- iliac, thrombosis of, 237

## Vitallium in reconstruction of duct, 261

## Wall, abdominal, perforation of, 386

## War

- amputations, treatment of, 184
- surgery after (E.), 137

## Whitehead and his work, 83

## Xanthoma of knee joint, 234

